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ANOTHER LARGE WESTERN WATER-POWER enterprise is under way, which is designed to supply the cities of Tacoma and Seattle, Wash., with electric power by an electrical transmission system. The engineering firm of Stone & Webster, of Boston, Mass., is backing the Pierce County Improvement Co. in the undertaking, and from them we have the following outline of the work as planned: The power is to be derived from the Puyallup River, which flows from its source in the glacier of Mt. Rainier northwest to Puget Sound, into which it empties near Tacoma. About 40 miles from its mouth the river will be dammed and its water carried by flume and ditch a distance of 10¼ miles to a large open forebay. Two steel penstocks about 1,700 ft. long will lead from the forebay to a power house, giving a net head on the wheels of 850 ft. The flume will be built with a cross-section 8 ft. wide by 5 ft. high, and is to be built later to a height of 7 ft. The initial development will be for 20,000 HP. The forebay will be not less than 500 ft. by 300 ft., by 14 ft. deep, so that it will hold water enough to carry the full load of the plant for a period of two hours. The power station will contain four power units, each to consist of a single impulse wheel direct-connected to a 3,500-KW. generator, producing electric current at 2,300 volts pressure. This current will be transformed to one of 40,000 or 50,000 volts, feeding transmission lines to Tacoma and Seattle, distant respectively 30 and 40 miles from the power station. It is hoped that the plant will be in operation shortly after the beginning of the year 1904.

THE CAUVERY FALLS HYDRO-ELECTRIC POWER plant, constructed by the government of Mysore, India, was opened on June 30, 1902. This plant includes a 92-mile transmission line, in duplicate, from the Cauvery Falls located 475 miles above the Bay of Bengal, to the Kolar gold fields. The whole scheme appears to have been carried out substantially as described at length in our issue of Nov. 29, 1900. Three riveted steel penstocks, 45 to 36 ins. in diameter, ¼ to ½-in. thick, about 930 ft. long, each with three expansion joints, deliver the water under a head of 382½ ft. to six 60-in. Pelton wheels, each of 1,250 B. HP. The wheels were supplied by Escher, Wyss & Co., of Zurich, Switzerland. There are six three-phase generators, of 720 KW. at 2,200 volts, which, with other electrical equipment, came from the General Electric Co., of Schenectady, N. Y. The current is transmitted at 30,000 volts, as originally designed, but the duplicate lines are not cut into these equal sections, with connecting switches, as was proposed at the start, it being considered safer not to add so much switch gear under such high voltage. Either line is capable of transmitting the full current, and the whole length of either line may be used as desired. At the gold fields terminal of the main line the voltage is reduced to 2,300, and it is further reduced to 220 volts for motors under 100 HP. Thus far there are about 25 miles of distribution line. Owing to the high cost of fuel in the gold fields the government had no difficulty in selling 4,000 HP. in advance, under ten-year contracts, at the following rates per horse-power year: $141 for the first year, $88 for the next three years, $117 for the fifth year, and $49 for the last five years. It should be added that the government provides the electrical equipment at the gold fields. The capital cost of the whole scheme is given at $426 per HP. at the mines. The conception of this enterprise is credited to Capt. A. C. Joly de Lotbiniere, Deputy Chief Engineer of Mysore. Col. D. McNeil Campbell, R. E., is Chief Engineer of Mysore, and Lieut. J. C. Hunter was Resident Engineer. Mr. Axel Ekstrom was Chief Engineer in behalf of the General Electric Co. The London "Contract Journal" of Nov. 5 contains a description of the works, illustrated with numerous half-tones, and, as already stated, further details may be found in our issue of Nov. 29, 1900.

CIVIL SERVICE EXAMINATIONS will be held by the Municipal Civil Service Commission, 61 Elm St., New York city, as follows: Topographical draftsman, salary $3,000, Dec. 1; assistant engineer, salary $2,100, Dec. 3; leveler, salary $1,050 to $1,350, Dec. 5; assistant engineer, salary $1,200, Dec. 8; inspector of masonry and carpentry, salary $1,200, Dec. 10. S. Wm. Briscoe, Secretary, Municipal Civil Service Commission.

A CIVIL SERVICE EXAMINATION for structural iron designers for the Department of Public Works, Chicago, will be held at the City Hall, in Chicago, on Dec. 10. The scope of this examination will be spelling, penmanship, letter writing, mathematics, technical knowledge required for the position to be filled, and experience tending to qualify the applicant for that position. As this is a special examination for experts the applications filed will be governed by a section of the rules which waives the requirement of local residence in special examinations. Those desiring to take this examination must file their applications with the Civil Service Commission prior to the date of examination. Further information may be obtained on application to Mr. T. J. Corcoran, Secretary of the Commission, Room 400, City Hall, Chicago, Ill.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Pennsylvania R. R. near Bolivar, Pa., on Nov. 17. An extra freight train ran into an engine running light: the two engines were destroyed and two of the trainmen killed.

A DAM FAILED near Red Cliff, Colo., on Nov. 6. It was built across the Eagle River. The dam was owned by the Denver & Rio Grande Railroad Co.

BIDS FOR A STREET RAILWAY and electric lighting franchise for Manila, P. I., are wanted by the municipal board until March 4, 1903. The franchise will be for 50 years. The street railway lines will be 35 miles long. The street car fares must not exceed 7½ cts. for first-class and 5 cts. for second-class passengers, both gold standard. The competition for the franchise will be based on the percentage of gross earnings, with a minimum of 1½%; also on the price of lights to the city. The city is to have the right to buy out the company at the end of 25 years, at a price to be fixed by arbitration, and to be based on the net earnings. The rates of fare are also to be readjusted at the end of 25 years. For further information address Col. Clarence R. Edwards, U. S. A., Chief of Bureau of Insular Affairs, War Department, Washington, D. C.

A PORTABLE ELECTRIC FIRE PUMP has been built at Rouen, France. A centrifugal pump is driven by an 8-HP. motor, connected to an electric light or power wire. The feed and return wires, each about 650 ft. long, are wound on reels placed on the wagon carrying the apparatus. It is said that the equipment described can be put in operation in about one minute and will throw 92 gallons of water per minute through a 0.7-in. nozzle attached to 650 ft. of hose, the water reaching 115 ft. beyond the nozzle. The weight of the pump, motor and accessories, mounted on a two-wheeled cart, together with two men, is given as about 2,300 lbs., or 3,000 lbs. when hose, axes and other supplies are added. The idea of the pump was suggested to M. Robert Lefebre, Captain of the Rouen Fire Co., by a German engineer at the Berlin Fire Extinguishing Exposition. The apparatus is described a little more fully than the foregoing by Mr. Thornwell Haynes, U. S. Consul at Rouen, in the "Advance Sheets of Consular Reports," for Nov. 13, 1902.

A NEW RAILWAY THROUGH GUATEMALA is now assured. The Central American Improvement Co., President, James McNaught, of New York, has been incorporated in New Jersey with capital stock of $5,000,000. The company has purchased about 120 miles of the Guatemala Northern R. R., and 76 miles of the Central Railway of Guatemala, leaving but 40 miles to be built to connect these two lines. This 40 miles, however, will be extremely heavy work, estimated to cost $1,500,000, even at the very low rate of wages that will be paid, 23 cts. a day in gold to each of 5,000 soldiers that the government agrees to furnish. When finished, this road will effect a saving of 1,500 miles between New York and San Francisco; for, after making certain changes in the existing lines, the distance from San Jose, on the Pacific Ocean, to the Port of Barrios, on the Caribbean Sea, will be only 202 miles. The contract for the work is said to have been let to the James P. McDonald Contracting Co., of New York, and the work is to be finished in ten months.

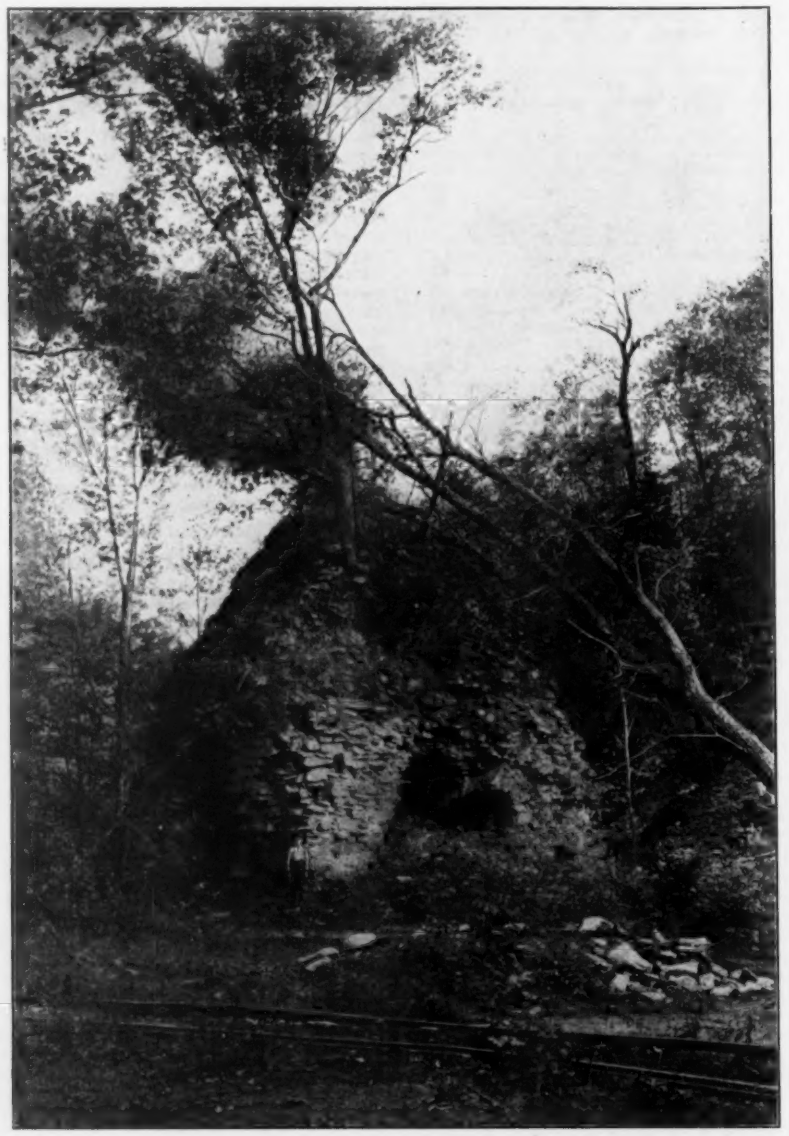
A SINGLE-RAIL RAILWAY has been built near Baltimore, Md., by Mr. Howard H. Tunis. The line is a loop track about half a mile in length and a car weighing about 3 tons is propelled over it by a 4-HP. kerosene engine. The system, which was patented by Mr. Tunis, Jan. 7, last (No. 690,539), is very similar to the famous old "Bicycle railway" of E. Moody Boynton, which was exploited to some extent a dozen years ago. In each case the cars are kept upright by a stationary framework at the sides of the track; but where Boynton had light overhead wheels on the car, Tunis has a long "balance rail," as he calls it, on the car roof which bears against wheels carried by the stationary frames at the side of the track.

"SERVE" TUBES FOR LOCOMOTIVE BOILER FLUES, which were claimed to show considerable economies on European railways and have been generally successful in Scotch marine boilers, have proved a total failure in American locomotives. A recent Institution of Civil Engineers paper describes experience with a Vauclain compound from the Baldwin Locomotive Works, on the Wellington & Manawatu Ry. of New Zealand. The locomotive was fitted with Serve tubes 11 ft. 6 ins. long. These required cleaning out twice as often as plain tubes and gave great trouble from leakage, doubtless owing to the greater expansion and contraction of the interior ribs under variation of temperature. The ends of the tubes for 6 ins. or so were made plain, without ribs, and serious grooving took place here. The author of the paper ascribes this to the concentration of expansion and vibrations at the thinnest and weakest part of the tubes. After a year's service it was found necessary to replace all the Serve tubes with plain tubes. Full records showed that the engine consumed no more coal when fitted with the plain tubes than with the Serve tubes.

AN IMPROVED HIGH-SPEED TOOL STEEL is said to have been produced by a new process at the Bismarck Furnace, in Silesia, Germany. The new material is claimed to greatly exceed even the tool steel made by the Taylor-White process in cutting power, and to have the added advantage that it will work successfully with much smaller cuts than the latter material. Thus it may be used on ordinary machine tools to increase their efficiency, whereas the Taylor-White steel can only develop its full efficiency on specially strong and powerful machines. In the note from which we gather our information, contained in a recent issue of the "Zeitschrift des Oestreichischen Ingenieur und Architekten Vereins," some comparative figures are given, thus: A certain steel shaft of hard steel (tensile strength 78,000 lbs. per sq. in.) was given a cut of .024 in. with a feed of .12 in. Using ordinary tool steel it took about 280 min. to cover the surface of the shaft (about 775 sq. ins.); with Taylor-White steel it took 140 min., whereas a tool made of the new material did the work in about one hour. It is stated that in working soft steel, with the new tool steel, taking a fine finishing cut, a peripheral velocity of 5½ ft. per second could be reached, while other tool steels could not be made to cut at all at this speed.

THE OLDEST IRON FURNACE WEST OF THE ALLEGHENY MOUNTAINS.

We reproduce herewith a photograph of one of the first iron furnaces built in the United States. Its great age might be inferred from the existence of the 15-in. elm tree shown in the photograph, but we are able to give with exactness the date of its building. In Ellis' "History of Fayette County" (Pa.) the statement is made that the "Alliance Furnace," as it is commonly called, was blown in November, 1789. In 1792 Gen. Knox, then the Secretary of War, wrote to Maj. Isaac Craig, who commanded the post at Pittsburg, asking him whether shot for the six-pounders could not be obtained from Turnbull & Marmie's furnace, as it was then called. It appears from a second letter a few weeks later that the shot had been ordered, and it is stated on good authority that the shot and shell used by Gen. Wayne in his expedition against the Indians in 1794 were cast at this same old furnace.



RUINS OF THE ALLIANCE IRON FURNACE ON JACOBS CREEK, FAYETTE COUNTY, PA., BUILT 113 YEARS AGO.

The furnace was built by Turnbull, Marmie & Co., a firm of Philadelphia merchants, which became interested in the development of the territory west of the mountains and started a branch of their business in Pittsburg. Wm. Turnbull was a commissary and purchasing agent for the Pennsylvania troops during the revolution, Peter Marmie was a Frenchman who came to the United States as the private secretary of Lafayette. In 1797 Turnbull appears to have disposed of his interest in the furnace and lands to Col. John Holker, a former French naval officer. Holker and Marmie operated the furnace until 1802, when it was finally abandoned, but the lands remained in Holker's possession until 1821.

The furnace is located about seven miles west of Scottdale, Pa., on Jacob's Creek, about 2½ miles from its junction with the Youghiogheny River. About a quarter of a mile up the creek from the furnace are the ruins of a forge where the iron made in the furnace was probably worked up, the stream being dammed and the power used to drive the hammer.

The furnace is about 25 ft. square and 25 ft. high as it now stands and is provided with two arches. Charcoal was the fuel used, and on the right side of the photograph is seen the end of the wall of the charcoal house, which is some 2[illegible] thick, 18 ft. high and 60 ft. long. The end walls, which are now falling down, are 30 ft. long.

A trestle formerly connected the charcoal house and the furnace; over this trestle the ore and charcoal were wheeled to the furnace. The iron ore was mined in the hills of Westmoreland County, where one can still see the dumps and the deep pits marking the site of the old workings. Excavations are to be found for half a mile along the hill.

There is a tale which, by the way, is pure myth, to the effect that Peter Marmie met his death by hurling himself into the furnace after driving his hunting dogs into the flames before him, from which it would appear that even in "those good old days" the ways of the ironmaster were not always "paths of glory"—or of profit, the fall doubtless springing from what poor Marmie often felt like doing.

We are indebted to W. North Robins, C. E., of Scottsdale, Pa., and through him to Prof. O. P. Medsgar, of the Alverton (Pa.) High School, for the facts relating to, and the photograph of, the Alliance furnace, the oldest west of the Allegheny Mountains, and probably the only one in blast up to the time its fires went out in 1862. In speaking of the furnace, Dr. Frank Cowan, of Greensburg, Pa., says: "The stack is still standing, but in ruins—the most impressive and picturesque of the ancient structures of southwestern Pennsylvania, concealed in a forest of seventy-five years' growth, the scene of many a strange story of the wilds of Barren Run."

THE CONSUMPTION OF WATER IN CITIES AND TOWNS IN MASSACHUSETTS.

An extended study of water consumption in Massachusetts, designed to cover all available reliable records since the various water-works were installed, is given in the report of the Massachusetts State Board of Health for 1900. Of the 166 cities and towns having public water supplies, 49 are supplied by gravity, 109 by pumping and 8 by the two processes combined. Deducting 23 towns having joint supplies, there are 86 water-works where all the water is pumped. Of these the records for 80 different works are available for from 1 to 25 years, often going back to the date the works were built.

These yearly records occupy 13 pages of the report, and include the population total and per capita (based on total population) average daily consumption, number of services and percentage of the same metered, and length of distributing pipes. The populations for inter-census year (Massachusetts has a census of its own half way between the U. S. Census) is based on the assumption "that the rate of growth between any two census years is uniform."

The variation in consumption due to different classes or types of cities is illustrated by the following classification of average per capita consumption in gallons per day in 1900:

Metropolitan water district	113
Average of 11 suburban cities and towns	69
" of 12 of the larger manufacturing cities	90
" of 33 smaller manufacturing cities and towns	42
" of 7 summer resorts	66

The first group includes the cities of Boston, Somerville and Chelsea, as well as smaller subur-

TABLE I.—Relation between the Quantity of Water Passed Through Meters and the Total Quantity of Water Pumped in 1900 in those Massachusetts Cities and Towns in which a Large Proportion of the Services are Provided with Meters.

City or town.	No. of services—Metered.	No. of services—Unmetered.	No. of services—Total.	Per cent. of metered services.	Quantity—Pumped. galls.	Quantity—Metered. galls.	Per cent. metered.
North Attleborough	846	0	846	100	95,800,000	35,658,000	37
Weston	128	0	128	100	19,019,000	8,000,000	42
Winchendon	373	14	387	96	20,542,000	9,697,000	47
Ware	735	39	774	95	104,744,000	50,778,000	57
Fall River	6,544	399	6,943	94	1,588,776,000	772,909,000	56
Worcester	12,536	756	13,292	94	2,975,716,000	1,614,623,000	54
Reading	962	96	1,058	91	54,250,000	33,450,000	62
Wellesley	799	79	878	90	87,194,000	46,279,000	53
Newton	6,001	1,086	7,087	85	761,526,000	419,000,000	55
Brockton	4,300	975	5,275	82	429,002,000	218,179,000	51
Lawrence	4,651	1,392	6,043	77	1,210,632,000	525,047,000	43
Attleborough	957	508	1,465	65	165,174,000	65,523,000	40
Lowell	5,586	5,048	10,634	53	2,881,075,000	775,194,000	27
Marlborough	1,141	1,103	2,244	51	179,922,000	66,055,000	37
Orange	299	293	592	51	57,571,000	14,776,000	26
Framingham	562	668	1,230	46	157,840,000	66,502,000	42
Foxborough	212	246	458	46	64,206,000	8,733,000	14
Norwood	461	584	1,045	44	145,821,000	35,054,000	24
Middleborough	349	479	828	42	85,092,000	41,102,000	48
Taunton	1,832	2,670	4,502	41	600,323,000	222,532,000	37
Walpole	150	304	454	33	58,532,000	27,214,000	46

ban cities and towns. The second group covers territory adjacent to or just outside the first. The third group embraces Lowell, Fall River and New Bedford.

The increase in consumption with the age of works is shown by averaging the per capita consumption for 24 cities and towns for ten years after the introduction of water. The places involved are not given, but the figures increased from 23 gallons per capita per day in the first year to 43 in the tenth year.

A goodly amount of space is devoted to the effect of water meters on the consumption of water. The average consumption of water in 1900 in three groups of cities with various percentages of their taps metered, was as follows: 24 places with more than 75% of taps metered, 40 gallons; 24 cities with more than 25 but less than 75% of metered taps, 47 gallons; 31 cities with less than 25% of metered taps, 60 gallons. During 1891-1900 the 17 towns in which the taps metered increased by more than 15%, showed an increase in average consumption from 39 to 48 gallons, against 43 to 64 for 23 towns with less than 15% increase in metered services.

One of the most notable exhibits in the report is a table comparing the per cent. of metered services and of water passing through meters in 21 cities and towns during the year 1900. These figures are reprinted here as Table I. It will be noted that in none of the places with 90% or more of their taps metered, is over 62% of the water accounted for. The 62% is in Reading, where 91% of the taps are metered. North Attleborough and Weston, with all taps metered, account for only 37 and 42%, respectively, of the water pumped. The report states that:

> The cause of this difference, which may be due to leakage in the pipes or imperfect meters, or errors in the rating of the pumps, or, possibly, a combination of two or more of these and other circumstances, has not been definitely ascertained in most cases.

TABLE II.—Per Cent. Which the Consumption During Each Month is of the Average Monthly Consumption of Reporting Cities and Towns During the Year, from 1896-1900, Inclusive, Together with the Rainfall and Average Monthly Temperature.

Month.	Per cent. consumption average for year.	Rainfall, ins.	Temperature, degs. F.
January, 1896	90	1.97	22.5
February	89	4.85	26.2
March	87	5.90	29.7
April	88	1.41	47.7
May	110	2.54	60.6
June	113	2.96	65.0
July	125	3.82	71.4
August	122	2.63	69.5
September	102	6.67	60.3
October	92	3.60	47.2
November	87	2.99	43.7
December	88	1.76	26.5
January, 1897	90	3.81	25.8
February	92	2.51	27.4
March	88	3.03	34.6
April	90	2.89	47.6
May	93	4.55	57.5
June	106	5.03	62.0
July	123	7.86	71.9
August	116	4.70	67.4
September	112	2.14	60.8
October	102	0.80	51.3
November	93	6.52	38.7
December	93	4.67	30.9
January, 1898	91	5.53	25.1
February	94	4.58	28.6
March	90	2.07	40.4
April	88	4.88	42.8
May	91	4.72	55.8
June	110	2.27	65.9
July	124	4.55	71.3
August	112	7.24	70.8
September	112	2.33	64.0
October	96	7.13	52.0
November	90	6.62	38.8
December	95	2.78	27.8
January, 1899	84	4.20	25.1
February	91	4.64	23.1
March	86	6.90	31.8
April	86	1.74	45.9
May	103	1.33	57.2
June	135	3.30	68.3
July	123	3.69	70.2
August	120	2.04	67.9
September	104	5.07	60.0
October	92	2.55	52.4
November	89	2.24	38.9
December	85	1.78	32.1
January, 1900.	83	4.43	26.9
February.	83	7.64	26.1
March	83	5.03	31.0
April	81	1.95	45.8
May	90	4.88	54.8
June	118	2.41	66.9
July	141	2.68	71.8
August	127	2.31	70.1
September	121	3.71	64.0
October	93	4.00	55.2
November	91	5.23	41.9
December	87	2.63	29.3

*Of course the actual quantities are not affected, except in so far as decreased consumption increases the pressure, and therefore the leaks.

TABLE III.—Relation of the Average Per Capita Consumption of Water During the Month, Week and Day of Maximum Consumption to the Average for the Year.
(Average of six years from 1895 to 1900, inclusive, expressed in gallons.)

City or town.	Average for six years.	Maximum consumption — Monthly. Actual, galls.	Monthly. Average, %	Weekly. Actual, galls.	Weekly. Average, %	Daily. Actual, galls.	Daily. Average, %
Abington and Rockland	39	54	138	63	167	88	233
Andover	54	67	127	74	139	150	264
Attleborough	36	47	130	62	154	88	245
Avon	31	42	137	55	180	109	367
Ayer	37	51	140	66	181	96	266
Beverly,	70	98	140	114	163	156	222
Braintree	71	85	120	83	143	137	194
Bridgewater and East Bridgewater	24	27	116	31	130	41	175
Brockton	30	40	134	40	164	69	232
Brookline	85	105	124	146	100	167	184
Cambridge	81	94	113	109	138	145	180
Canton	40	54	134	64	158	87	216
Cohasset	34	62	177	62	250	95	340
Cottage City	93	251	271	296	318	383	419
Danvers	69	84	119	96	134	127	181
Dedham	71	91	127	103	149	126	183
Easton	21	29	135	38	181	51	245
Fairhaven	48	70	153	73	165	114	258
Fall River	36	43	121	47	130	54	150
Foxborough	50	60	119	68	135	100	200
Framingham	36	44	122	52	143	71	194
Franklin	35	47	136	72	206	82	245
Gardner	62	77	125	80	128	113	169
Gloucester	32	41	129	47	142	64	193
Hyde Park and Milton	42	61	146	62	147	70	166
Ipswich	18	32	173	29	160	100	542
Lawrence	55	62	111	74	134	90	164
Longmeadow	64	90	146	117	185	177	285
Lowell	79	92	117	102	130	118	150
Lynn and Saugus	67	78	116	84	125	118	177
Manchester	76	142	186	163	214	224	296
Mansfield	33	46	134	59	177	79	236
Marblehead	49	79	160	92	187	127	264
Marlborough	37	43	119	44	119	80	220
Maynard	30	43	143	57	180	140	482
Metauen	33	42	126	51	151	80	217
Middleborough	32	41	125	51	160	72	218
Milford and Hopedale	61	74	121	83	136	97	158
Montague	67	80	122	89	127	132	202
Nantucket	92	70	218	80	249	95	296
Natick	42	56	134	80	191	135	322
Needham	50	57	114	64	128	79	158
New Bedford	96	108	113	121	126	145	151
Newburyport	41	46	114	52	128	64	157
North Attleborough	30	40	136	39	138	53	176
North Brookfield	35	45	134	62	184	103	308
Norwood	71	84	119	89	129	176	261
Orange	24	31	130	42	173	70	300
Peabody	89	102	114	113	127	139	155
Provincetown	29	52	187	67	224	127	480
Randolph and Holbrook	46	72	161	96	226	131	306
Reading	32	51	154	69	206	111	328
Rockport	34	53	151	73	194	89	266
Salem	67	77	114	80	119	119	178
Sharon	26	57	216	67	258	88	336
Stoughton	43	52	122	59	146	77	192
Taunton	46	53	116	58	127	67	147
Tisbury	37	74	196	93	253	110	304
Wakefield and Stoneham	53	66	124	57	127	102	182
Walpole (five years only	30	40	136	61	188	91	328
Waltham (five years only.)	76	84	115	99	135	134	188
Ware	32	40	123	43	133	92	283
Webster	34	39	117	42	125	59	175
Wellesley	42	54	130	66	157	82	236
Whitman	29	43	149	54	188	66	231
Woburn	73	90	123	106	145	160	218
Worcester (less than six years)	58	75	117	86	128	110	165

We may add that the curtailment of that portion of waste preventable by the use of meters increases the percentage of leakage on the street side of the meters, the pump slippage and the under-registration of meters.*

A compilation of the consumption of water in the census year 1890, 1895 and 1900 for 40 cities and towns outside the metropolitan district, shows an increase of 15% from 1890 to 1895, and 8% from 1895 to 1900. In the metropolitan district the increase was 26% from 1890 to 1895 and 23% from 1895 to 1900. This is one of those cases where percentages are apt to mislead, since the actual figures were 52 gallons in 1890, 60 in 1895 and 65 in 1900, outside the metropolitan area, and 73, 92 and 113, respectively, within that district.

Table II. shows the average percentage relation between monthly and yearly consumption, the rainfall, and the temperature for the six years 1895 to 1900, in all places (number not stated) for which the necessary figures were obtained.

In general, the report states the consumption varies with the rainfall (in warm weather?) and extremes of heat.

Table III., also based on the records for six years, compares the average daily consumption for the whole period with the maximum monthly, weekly and daily consumption. As the report well says:

> These records are apt to be misleading in the case of the smaller towns, as they show the amount of water pumped and not the amount of water used, and in certain cases the amount of water pumped is excessive, owing to the filling of an empty reservoir or a serious leak in the distributing pipes.

The foregoing remark, we should say, applies more particularly to the maximum daily consumption, somewhat to the weekly figures, and probably seldom to the monthly.

The study concludes with the following sensible remarks regarding the desirability of records of the consumption of water where the gravity system of supply prevails:

> It is interesting to note that while the consumption of water in many of the municipalities in which more or less careful records of consumption are kept is quite large and continues to increase, studies and estimates of the quantity of water used in many other cities and towns, in which the water is supplied wholly by gravity and no attempt to measure the quantity used is made, show that the quantity supplied to such cities and towns is probably very much larger, on the average, than in cases where all of the water is pumped or records of the quantity used are kept. In some places, in which no measurement of the quantity of water supplied is kept, there are indications that the quantity used in proportion to the population is excessive. While pumping records may not be very reliable evidence in all cases of the quantity of water supplied to a city or town, they nevertheless serve, as a whole, to give a very fair indication of the quantity of water being used, and show quite clearly when the quantity supplied is becoming excessive. In cases where water is supplied by gravity it is generally considered unnecessary and often a waste of money to attempt to make any continuous and approximately correct record of the quantity of water used. There is no doubt, however, that in many such cases a knowledge of the excessive use of water would lead to a great reduction in waste and to a saving in the cost of construction and operation of the works far greater than the expense of making the necessary measurements.

SOME INTERESTING LONG SPAN BRIDGES NOW UNDER CONSTRUCTION.

From time to time during the past year we have had occasion to mention and briefly describe several large bridges of more than ordinary interest which are now under construction, and in the present article it is proposed to describe the general design and special features of these structures more fully, without, however, going into the details of construction. These bridges, seven in all, include four railway cantilever bridges (one of which is the longest single span bridge in the world), a highway cantilever bridge with anchor arms of unequal length, a double-deck four-track bridge, and a three-hinged steel arch railway bridge.

One of the notable features in the four railway

cantilever bridges is that all are to carry double track lines. In the past, very many of the large bridges in America have been built for a single track only. This has been partly on account of the expense, and partly on account of the fact that they formed connecting links in single-track railway systems. Many of the railways using such bridges, however, have since been double-tracked, and now have more or less inconvenience in operating their traffic over the single-track bridges. The new Mississippi River bridge will connect four important railway systems, and the traffic will evidently be sufficient to warrant the additional cost of a double-track structure. The other cantilever bridges are built for double track, as they form part of a double-track line.

The double-deck bridge and the unsymmetrical cantilever bridge are examples of designs made to meet certain limiting conditions, while the steel arch is an example of the adoption of a special type of bridge for a situation to which this type is peculiarly adapted.

CANTILEVER BRIDGE OVER THE MISSISSIPPI RIVER.

Probably the largest and most important bridge now under construction in the United States is the great cantilever bridge over the Mississippi River, between Thebes, Ill., and Gray's Point, Mo. The bridge and its approaches, with a few miles of railway on each side of the river, will be built by the Southern Illinois & Missouri Bridge Co., whose line will form a connecting link between the Illinois Central R. R. and Chicago & Eastern Illinois R. R., on the east side, and the St. Louis Southwestern Ry. and Missouri Pacific Ry. on the west side. All these railways are represented in the bridge company. At the present time communication between these lines is effected by car ferries, as noted in an article on the Thebes extension of the Chicago & Eastern Illinois R. R. in our issue of April 12, 1900. The entire line of the Southern Illinois & Missouri Bridge Co., 6½ miles in all, will be double track. Fig. 1 is a plan and elevation of the bridge, while Fig. 2 shows sectional elevations of the bridge and masonry viaduct.

The bridge proper will be 2,750 ft. long, consisting of five spans. Each anchor arm forms one of the intermediate spans, with cantilever arms extending over the center and shore spans. The main shannel span is 671 ft. long with cantilever arms of 152 ft. 6 ins. and a central suspended span of 366 ft. This is flanked on each side by the span of 521 ft. 2 ins., formed by the anchor arm, while each shore span of 518 ft. 6 ins. consists of a cantilever arm of 152 ft. 6 ins. and a suspended span of 366 ft. There are two lines of through trusses, 32 ft. c. to c., or 28 ft. apart in the clear, with a depth of 75 ft. in the anchor arms, 50 ft. at the ends of the cantilever arms, and 55 ft. at the center of the suspended span. The clear headway at portals is 22 ft. 6 ins. The elevation of the bridge is 103 ft. above low water (zero on the U. S. gage at Gray's Point), and 65 ft. above high water line.

The total weight of the superstructure will be about 12,000 tons. The live load for the floor system is assumed as 50,000 lbs. concentrated load, and 5,000 lbs. per ft. of track; live load for trusses, 20% less. Wind pressure, 1,000 lbs. per ft. of bridge. The trusses will be of pin-connected construction with panels 30 ft. 6 ins. long in the suspended span and cantilever arms, and 32 ft. 6⅞ ins. long in the anchorage span. Plate girder floor beams will be riveted between the truss posts, and between the floor beams will be four lines of plate girder track stringers. In the erection, falseworks will be used in the four side spans, but not in the channel span. The material used in the superstructure will be open-hearth steel, of the following grades:

Steel:	Ultimate strength, lbs.	Elastic limit, min., lbs.	Elongation in 8 ins.	Reduction in area.
Medium	62,000 to 70,000	35,000	22%	44%
Soft	52,000 " 60,000	30,000	26%	52%
Pin	62,000 " 70,000	35,000	18%	36%

There will be six concrete piers faced with limestone, and having bridge seats and cutwaters of granite, the stone being secured to the concrete by long dowels of 1⅛-in. steel rods. The pier at the west end will have its foundation built in open excavation, as the rock is here near the surface. The other five piers will have their foundations sunk to bed rock by the pneumatic process.

The approaches will consist of arched viaducts of concrete masonry. That on the east side will have five 65-ft. semicircular spans, while that on the west side will have six 65-ft. spans and an end span of 100 ft. The end piers will each form a part of the approach viaduct. Between the spandrel walls will be a filling of sand up to the subgrade level, this filling being consolidated by flooding. Over the haunches this filling will be underlaid by a bed of rough stone, allowing for drainage through to the pipes built into the concrete. Unlike many of the masonry railway bridges and viaducts now being built, the approach viaducts will have high parapets. The coping course and parapet walls will not be formed in one piece with the body of the work, but will be built separately and secured in place by steel bars and dowels. This construction will be in general similar to that of the parapets of the concrete Y-bridge at Zanesville, O., described in our issue of March 27, 1902. Over each viaduct pier will be a 1-in. open expansion joint in the spandrel walls, the joint being loosely packed with asbestos and coated with asphalt to prevent it from being filled with dust or gravel. No steel work will be used to reinforce the concrete, but 1¼-in. rods will be built into the spandrel walls and in the face of the arch, close to the intrados, to prevent surface cracks.

The proportions of the concrete depend upon the voids in the crushed stone, but approximately the proportions will be as follows: 1 part cement, 2 parts sand and 5 parts stone (also 1 to 3 to 7), for different parts of the foundations; piers, 1 to 2½ to 6; arches and spandrel walls, 1 to 2 to 5; coping and parapet, 1 to 2 to 4. The molds will not be plastered with cement mortar, but the concrete will be worked with a spade at the face, so as to force back the stones and leave a mortar facing.

The bridge was designed by Messrs. Alfred Noble, M. Am. Soc. C. E., and Ralph Modjeski, M. Am. Soc. C. E., 1742 Monadnock Block, Chicago, who are also the engineers for the entire work of the Southern Illinois & Missouri Bridge Co. To them we are indebted for plans and information. Mr. W. E. Angier, Assoc. M. Am. Soc. C. E., is Resident Engineer, at Thebes, Ill. The contract for the construction and erection of the complete superstructure was awarded to the American Bridge Co., of New York. The contract for the concrete piers and foundations was awarded to C. Macdonald & Co., of New York; the contract for the concrete approach viaducts to the J. S. Paterson Construction Co., of Chicago, and that for the grading of the approaches to McArthur Bros., of Chicago. The Chicago & Eastern Illinois Ry. will build a loop line about four miles long to connect its low level line (along the river bank) with the bridge.

The Act of Congress authorizing the construction of the bridge requires that it shall be completed in January, 1904. The general estimate of the approximate cost of the work is as follows:

Superstructure	$1,300,000
Substructure (main bridge)	540,000
Concrete approaches	270,000
Earthwork approaches	280,000
Engineering and contingencies	210,000
Total	$2,600,000

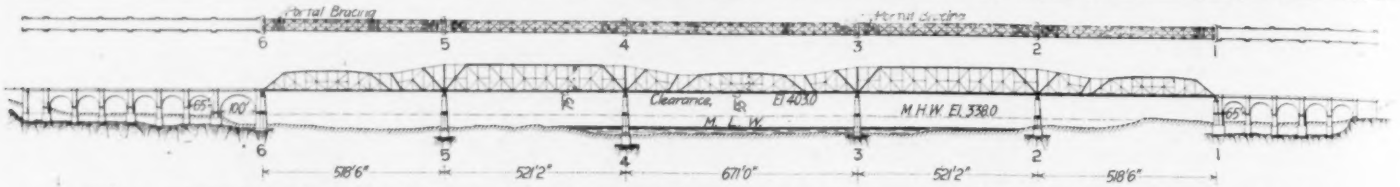


FIG. 1. CANTILEVER BRIDGE OVER THE MISSISSIPPI RIVER AT THEBES, ILL.; SOUTHERN ILLINOIS & MISSOURI BRIDGE CO.
Alfred Noble and Ralph Modjeski, Members Am. Soc. C. E., Chicago, Engineers.

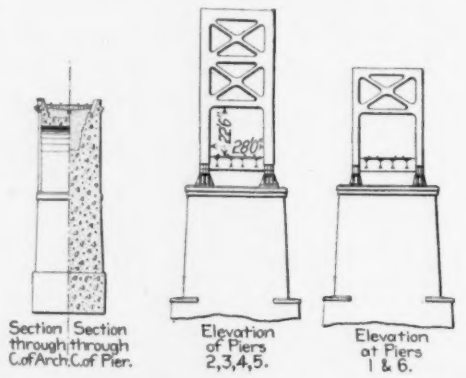


Fig. 2. End Elevations and Cross-Section; Mississippi River Bridge.

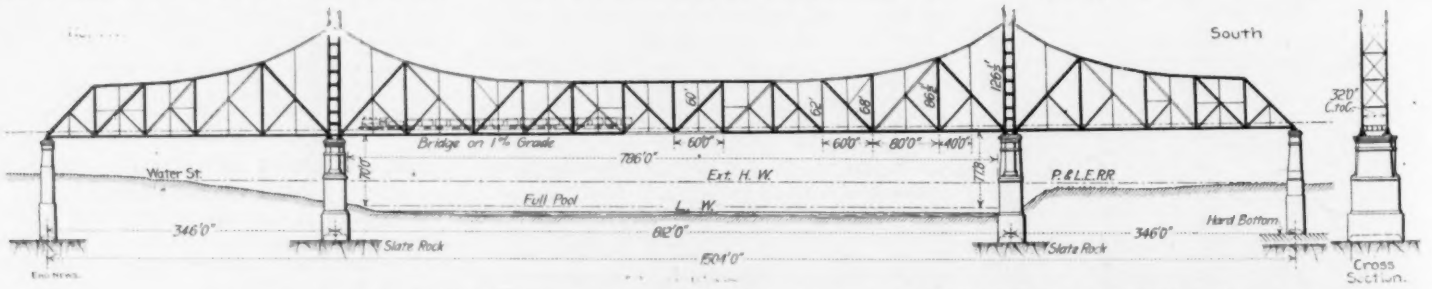


FIG. 3. CANTILEVER BRIDGE OVER THE MONONGAHELA RIVER AT PITTSBURG, PA.; WABASH R. R.
Boller & Hodge, New York, N. Y., Consulting Engineers; American Bridge Co., New York., N. Y., Contractors.

CANTILEVER BRIDGE OVER THE MONONGAHELA RIVER AT PITTSBURG, PA.; WABASH R. R.

The Wabash R. R. has now under construction a new line by which it will obtain access to Pittsburg, Pa., as described in our issue of June 12, and this extension will enter the city by a double-track cantilever bridge 1,504 ft. long, with channel span 812 ft. c. to c. of piers. This will be the longest single span railway bridge in this country, and the bridge is of special interest on account of the magnitude of its parts, the heavy loading, and the fact that it is to be a double-track structure. A general elevation of this structure is shown in Fig. 3. At the south end is a through span and a plate girder viaduct approach, 404 ft. in length, ending at the anchorage pier of the south anchor arm, which is 346 ft. c. to c. of piers, and crosses the Pittsburg & Lake Erie R. R. tracks. The cantilever arms are 226 ft. long, and carry a middle suspended span of 360 ft. The north anchor arm is also 346 ft. long, crossing Water St. and the levee, and from this extends a plate girder viaduct running to the new terminal station at Liberty Ave. and Ferry St. The bridge is on a rising grade of 1% from the north end, the clear headway above "full pool" level being 70 ft. at the north pier and 77.86 ft. at the south pier. The foundations will be sunk to rock by the pneumatic caisson process. The river piers will be of Beaver Valley sandstone, in ashlar masonry, with concrete hearting and granite bridge seats. The centers of the piers will be hollow, the exterior dimensions at high water level being 59 × 25½ ft., respectively. The anchor piers will be twin piers of monolithic concrete construction, 57½ × 13½ ft. over the coping, with interior well holes 4 × 6 ft. for anchor bars.

The trusses will be 32 ft. c. to c., with a heavy floor system carrying tracks 13 ft. c. to c. The steel towers are 12 × 32 ft., with a height of 126 ft. 6 ins. The depth of truss at the center and at the portals is 60 ft. The panel lengths are 30 and 40 ft., as shown. The lower chords are 36 ins. deep and 65 ins. wide. The eyebars are 12 ins. and 14 ins. wide, the former being used in the anchorages. These 14-in. bars will have heads 33 ins. diameter, and pins 12 and 14 ins. diameter, most of them being 12-in. It will be seen from the above particulars that the Monongahela bridge will be notable for the size of the eyebars used in its construction, and the engineers consider that in this bridge the limit of practical application of pin-connection work will about be reached.

The live load assumed consists of two consolidation engines (on each track), followed by a train load of 4,500 lbs. per lin. ft. The quality of steel for this bridge and all the bridges on the Wabash R. R. extension to Pittsburg was shown in a table accompanying a paper by Mr. A. P. Boller, M. Am. Soc. C. E., in our issue of June 26.

The bridge was designed by Messrs. Boller & Hodge, Consulting Engineers, Nassau St., New York, N. Y., under whose direction all the bridge work is being carried out. The contract for the substructure has been awarded to Arthur McMullen, of New York. The contract for the superstructure has been awarded to the American Bridge Co., of New York, and it may be noted that this company built a special plant for the manufacture of the large eyebars, as none of its present plants had facilities for making bars of the largest size required. This plant is at the company's new works at Economy, Pa., described in our issue of June 26. Work is now in progress, and the contract calls for the completion of the bridge by Jan. 1, 1903. The estimated weight of metal in the superstructure (exclusive of approaches) is 7,000 tons, and the estimated cost of substructure and superstructure is $800,000.

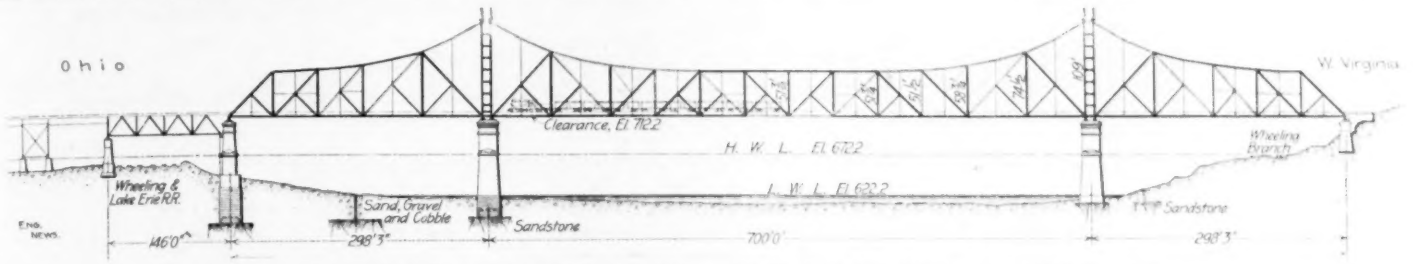


FIG. 4. CANTILEVER BRIDGE OVER THE OHIO RIVER AT MINGO JUNCTION, O.; WABASH R. R.
Boller & Hodge, New York, N. Y., Consulting Engineers; American Bridge Co., New York, N. Y., Contractors.

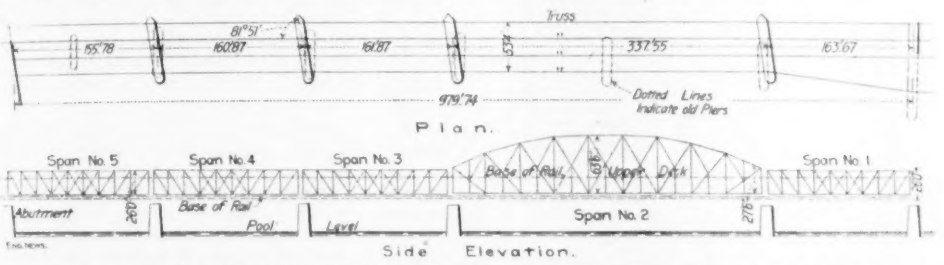


FIG. 5. DOUBLE-DECK BRIDGE OVER THE ALLEGHENY RIVER AT PITTSBURG, PA.; PENNSYLVANIA LINES WEST OF PITTSBURG.
Thomas Rodd, M. Am. Soc. C. E., Chief Engineer. J. C. Bland, M. Am. Soc. C. E., Engineer of Bridges.
American Bridge Co., New York, N. Y., Contractors.

CANTILEVER BRIDGE OVER THE OHIO RIVER; WABASH R. R.

The Pittsburg extension of the Wabash R. R. will also cross the Ohio River by a double-track cantilever bridge at Mingo Junction, O. This bridge is of very similar design to that over the Monongahela, but of somewhat smaller dimensions, as shown in Fig. 4. This will have anchor arms 298 ft. 3 ins., and a channel span of 700 ft. (cantilever arms, 194 ft. 9 ins.; suspended span, 316 ft. 6 ins.). At the east end (in West Virginia) the anchorage is an abutment on the river bank, and the east channel pier will have a shallow foundation on solid rock. The other piers will have caisson foundations. At the west (Ohio) end, is a deck truss span of 180 ft., followed by a plate girder approach viaduct. The clear headway over the channel is 90 and 40 ft. above low and high water, respectively. The towers are 10 × 31 ft., 109 ft. high, and the truss depth is 51 ft. 9 ins. at portals and center. The panel lengths are 25 ft. 10½ ins. and 34 ft. 6 ins.

This bridge was also designed by Messrs. Boller & Hodge, and the contracts have been let to the same contractors. The total weight of metal in the superstructure (exclusive of approaches) is 6,000 tons, and the cost of substructure and superstructure is estimated at $750,000.

For the line between these two large bridges Messrs. Boller & Hodge have designed about 30 viaducts and small bridges with a total weight of about 7,000 tons. The contract for all the superstructures has been let to the American Bridge Co., of New York, and the substructure work is being done by the contractors for the grading of the railway.

DOUBLE-DECK TRUSS BRIDGE OVER THE ALLEGHENY RIVER AT PITTSBURG; PENNSYLVANIA LINES.

In our issue of April 24, 1902, we described and illustrated the work of shifting the old bridge carrying the Pittsburg, Fort Wayne & Chicago Ry. (Pennsylvania Lines West of Pittsburg) over the Allegheny River at Pittsburg, to make way for a new structure. The design for the new structure is shown in Figs. 5 and 6. The old bridge (built in 1867) consisted of five through truss spans (162.51 ft., 168.91 ft., 159.79 ft., 161.86 ft., and 164.23 ft.), followed by two plate girder deck spans of 90 ft. 6 ins. at the west end, while at the east end were two deck spans of 80 ft. This bridge was double track, with three parallel-chord lattice trusses in each of the long spans. The two east end 80-ft. spans are replaced by a 30-ft. stone arch for Duquesne Way, and a solid floor plate girder structure over the tracks of the Pennsylvania Lines on Duquesne Way. The new bridge will cover the length of the five truss spans and the two west end plate girder spans (90 ft. 6 ins.) with five pin-connected truss spans on four new piers, as shown by the plan. Four of these spans will have parallel-chord trusses (163.67 ft., 161.87 ft., 160.87 ft., and 155.78 ft.); these will all have a depth of 26 ft. c. to c. of chords. The channel span will

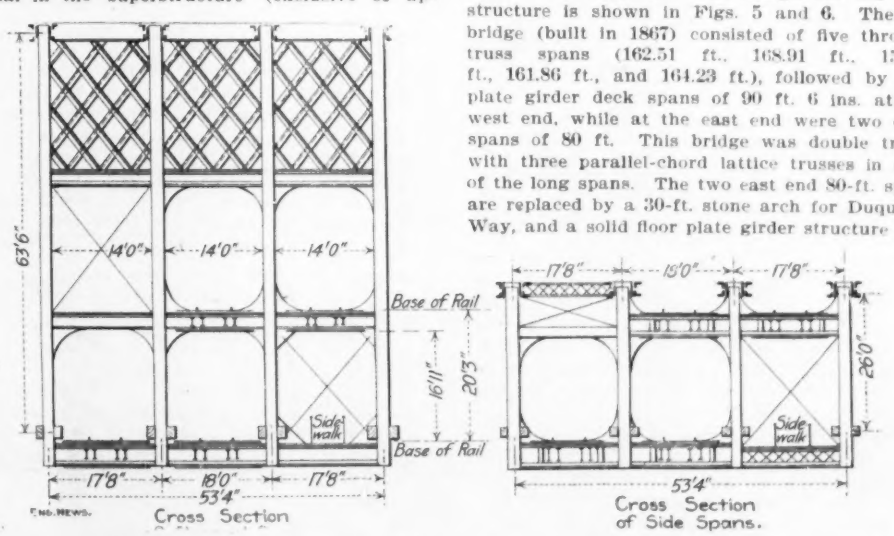


FIG. 6. CROSS-SECTIONS OF DOUBLE-DECK BRIDGE; PENNSYLVANIA LINES WEST OF PITTSBURG.

be 337.55 ft. long, c. to c. of piers, with a depth of 27 ft. 6 ins. at the ends and 67 ft. 6 ins. at the middle.

The bridge will be a four-track, double-deck structure, with four lines of trusses, spaced 17 ft. 8 ins. c. to c. at the sides and 18 ft. c. to c. at the middle. On the lower deck will be two tracks (in the center and one side bay), with a 6½-ft. sidewalk in the other side bay; this latter bay has vertical lateral bracing, which accounts for the narrowness of the sidewalk. On the upper deck will also be two tracks, one of which is over the sidewalk, the other side bay on this deck being closed by vertical lateral bracing. The braced bays (or transverse panels) in the two decks are thus diagonally opposite one another, as is shown by the cross-section of the channel span, in Fig. 6. In the shorter spans, the floor beams of the upper deck are placed a few feet below the top chords, and a shallow system of vertical lateral bracing is placed in one of the side bays of this deck. This is shown on the cross-section of the shorter spans, Fig. 6. The floor system consists of plate girder floor beams, with six lines of plate girder stringers under each track on the lower deck, and four lines of similar stringers under each track on the upper deck. The two tracks on the lower deck will carry the trains of the Allegheny Valley Division and also connect with the present system of surface tracks for local switching service. The two tracks on the upper deck will carry the main line trains, both passenger and freight, the bridge forming a link in the track elevation work now in progress through Pittsburg and Allegheny.

The material for the trusses and lateral system, under the railway company's specifications of 1897, will be open-hearth medium steel, with an ultimate strength of 66,000 lbs. (allowing a variation of 4,000 lbs. either way), and an elastic limit not less than 55% of the ultimate strength. The allowable percentage of elongation is that obtained by dividing the ultimate strength into the constant 1,500,000; the percentage of reduction of area is obtained by dividing the ultimate strength into the constant 2,800,000. The material for the floor system will be soft steel, with an ultimate strength of 50,000 lbs., allowing a variation of 4,000 lbs. either way. The shop rivets are to be of soft steel and the field rivets of wrought iron All rivets will be ⅞-in. diameter, except ¾-in. rivets in angles ⅜ × 3 × 3 ins. Holes in floor beams and stringers, in metal up to ½-in. thick, are punched to size; while all other holes are punched ⅛-in. smaller than the diameter of the rivet and then reamed to size. All field connections are reamed to cast-iron templets at the shop, or reamed after the parts are assembled. The live load for the floor system on each track is taken as 5,000 lbs. per lin. ft., plus a concentrated weight of 50,000 lbs.

The bridge was designed by the Engineering Department of the Pennsylvania Lines West of Pittsburg. The masonry work was done last year, the contractor being the Drake & Stratton Co., of Pittsburg, Pa. The contract for the superstructure was let to the American Bridge Co., of New York, and work on the erection has been commenced. The contract called for its completion about the end of July, 1902. The estimated weight of material in the superstructure is 6,800 tons, and the total cost of both substructure and superstructure is estimated at $1,000,000.

CANTILEVER BRIDGE OVER THE OHIO RIVER AT MARIETTA, O.

A cantilever highway bridge of peculiar design is under construction over the Ohio River at Marietta, O., by the Ohio River Bridge & Ferry Co., of which Mr. B. G. Dawes is president. The company now operates a steam ferry, and is interested in an electric railway on the south side of the river (opposite Marietta), running from the bridge site to Parkersburg, W. Va. The design, shown in Fig. 7, was prepared by Mr. C. L. Strobel, M. Am. Soc. C. E., who is the Consulting Engineer of the company, and the contract for the superstructure has been awarded to the American Bridge Co., the date for its completion being Jan. 1, 1903.

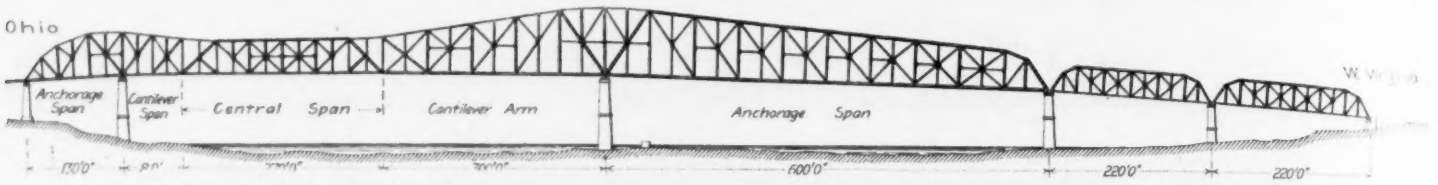


FIG. 7. UNSYMMETRICAL CANTILEVER HIGHWAY BRIDGE AT MARIETTA, O.; OHIO RIVER BRIDGE & FERRY CO.
C. L. Strobel, M. Am. Soc. C. E., Chicago, Consulting Engineer; American Bridge Co., New York, N. Y., Contractors.

As above noted, the design is somewhat peculiar. The length of the south anchorage span is 600 ft., while that of the north anchorage span is only 130 ft. This arrangement resulted from the necessity of maintaining two navigable channels

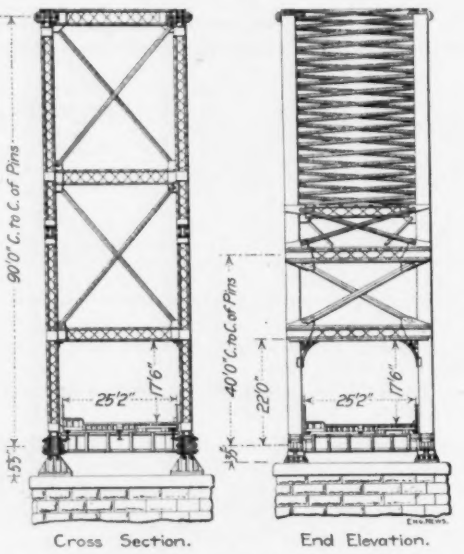


Fig. 8. Cross-Sections of Ohio River Bridge.

(the position of the three channel piers being fixed by the War Department), and by the fact that the south approach is a viaduct with a sharp curve, giving very little room for the anchorage span between the channel pier and the curve. The main channel span is 650 ft. c. to c. of piers, and this length is composed of a 300-ft. south cantilever arm, an 80-ft. north cantilever arm, and a 270-ft. central suspended span. The 300-ft. arm had, of course, to be made as heavy as though the span was to be 870 ft. instead of 650 ft., and the erection of this 300-ft. arm and of half the 270-ft. suspended span by projection will be the same operation as though the span was symmetrical and 870 ft. long instead of unsymmetrical and 650 ft. long. There are two lines of pin-connected trusses 28 ft. c. to c., the trusses having 30-ft. panels. The truss depth is 40 ft. at the end posts of the 600-ft. anchorage span, and 90 ft. over the middle channel pier. The clear headway at portals is 17 ft. 6 ins. The central suspended 270-ft. span is level, but the long and short anchorage spans have grades of 3% and 1½% respectively.

The width is 25 ft. 2 ins. c. to c. of railings, and includes a 4½-ft. sidewalk and a roadway, with a street railway track at one side of the latter. The floor system, Fig. 8, consists of plate girder floor beams between the truss posts, and three lines of I-beam stringers supporting subfloor beams spaced about 10 ft. c. to c. Timber stringers carry the ties for the street railway track, while the joists for the roadway are laid on cushion timbers or bolsters upon the floor beams, so as to bring the planking flush with the tops of the rails. These rails are of T-section, 4⅝ ins. high, with wooden paving blocks next to the rail. The sidewalk is carried in a similar manner, and provision is made for building a sidewalk outside the trusses at some future time, and increasing the width of the roadway between the trusses accordingly.

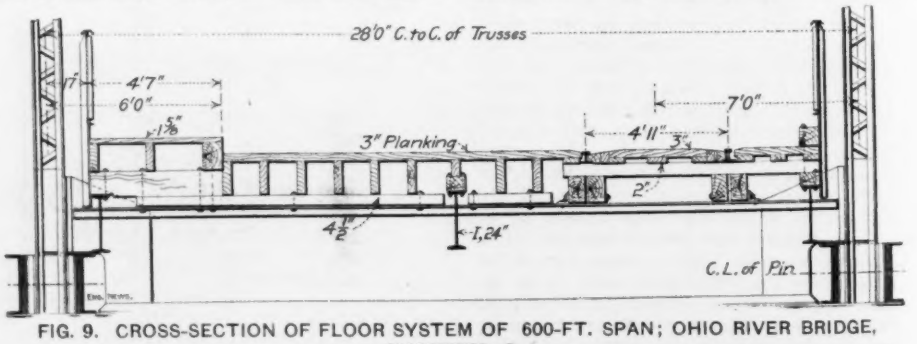


FIG. 9. CROSS-SECTION OF FLOOR SYSTEM OF 600-FT. SPAN; OHIO RIVER BRIDGE, MARIETTA, O.

The live load assumed for the floor throughout and for the plate girders in the viaduct is 80 lbs. per sq. ft., or an electric railway eight-wheel car of 30 tons or a steam roller of 15 tons. For the trusses it is 60 lbs. per sq. ft. on roadway and sidewalk. The material used is open-hearth medium steel, and the estimated weight of the superstructure (including the two approach spans and the viaduct) is 2,400 tons.

The approaches comprise two pin-connected through truss spans of 220 ft. each, on the south side; and a plate girder viaduct 640 ft. in length on the north or Marietta side. The piers and abutments are of stone masonry. The channel piers rest upon piles, cut off at the bed of the river; cofferdams were built around the piles, and after excavating all loose material concrete was rammed between and over the piles. The pier masonry was then built upon the concrete. The substructure work has been done by the company by day labor, under the direction of Mr. T. M. Ripley, Assoc. M. Am. Soc. C. E., Resident Engineer.

THREE-HINGED STEEL ARCH BRIDGE; CHICAGO, MILWAUKEE & ST. PAUL RY.

In Fig. 9 is shown a three-hinged arch bridge of 207 ft. span now being built over the Menominee River, on the Superior Division, near Iron Mountain, Mich. This structure will replace a deck span of the Pratt type, 255 ft. long, which was built about 17 years ago, and is too light for the present traffic. The river banks are of granite and the location was considered to present ideal conditions for an arch bridge, requiring a minimum amount of masonry. All of the substructure will be of concrete, and this is being built

by the railway company's forces, as is usual for this kind of work on the C., M. & St. P. Ry., very little substructure work being done by contract.

The superstructure has been proportioned throughout generally in accordance with Cooper's specifications for railway bridges (1901 edition),

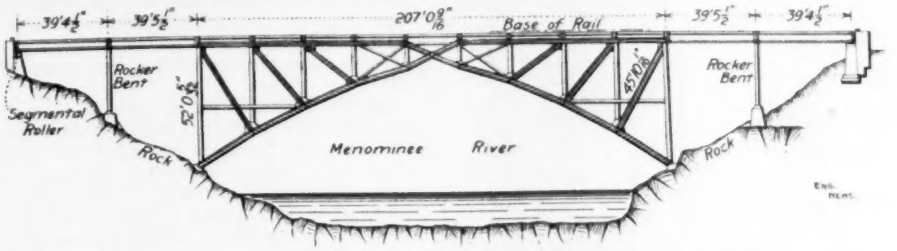


FIG. 10. THREE-HINGED STEEL ARCH BRIDGE; CHICAGO, MILWAUKEE & ST. PAUL RY.
C. F. Loweth, M. Am. Soc. C. E., Engineer and Superintendent of Bridges and Buildings; Phoenix Bridge Co., Phoenixville, Pa., Contractors.

and for a live load of two consolidation Class E-50 locomotives. For these the weights assumed by the specifications are 25,000 lbs. on each truck axle, 50,000 lbs. on each driving axle, and 32,500 lbs. on each tender axle. The distributed load or trainload behind the engines was taken as 7,000 lbs. per lin. ft.; this unusually heavy train load being adopted in order to provide for a heavy ore traffic. The steel will be of the grade commonly known as medium steel, with a tensile strength of 60,000 to 68,000 lbs. All rivet holes will be reamed, except in the lacing and laterals. The bridge was designed in the office of and under the direction of Mr. C. F. Loweth, M. Am. Soc. C. E., Engineer and Superintendent of Bridges and Buildings, Chicago, Milwaukee & St. Paul Ry. The superstructure is being built by the Phoenix Bridge Co., of Phoenixville, Pa., and was to be ready for traffic in the early autumn.

As shown by the detail drawing, Fig. 10, the bridge has two arched deck trusses, 22 ft. c. to c. Each arch is divided into nine panels of 23 ft 1-16-in., and has a rise of about 52 ft. The hinge pins are 8⅞ ins. diameter, with cast-steel skewbacks, while the pins for the eyebar members in the middle panels are 4 5-16 ins. diameter. The chords have double webs, with outside flange angles, and top and bottom latticing. The posts and diagonals forming the web members are composed of pairs of channels, except in the middle panels, where pairs of eyebars are used. The end posts are similar to the chords, except that the flange angles are on the inside, and at the top of the post will be noted a special pin plate for the attachment of temporary anchor bars during erection. These plates will afterwards be cut off.

The floor beams are plate girders fitted between the tops of the posts, except that the end floor beams are trusses. Upon these are plate girder stringers 8 ft. apart, with lateral bracing between them, and outside struts or braces to the top chords. The total weight of metal in the main span, exclusive of approaches, will be about 240 tons.

The approach on each side consists of two plate girder spans of 39 ft. 4½ ins. and 39 ft. 5½ ins., supported by an intermediate rocker bent, and having segmental roller bearings on the abutments. The weight of metal in the approaches will be about 75 tons.

The river is crossed on the skew, and it was impossible to shift the old bridge to a new temporary location without building expensive approaches. The new bridge had therefore to be designed so as to admit of its erection while keeping the old bridge in use. These conditions limited the design in certain ways, including the panel lengths, distance between trusses, etc.

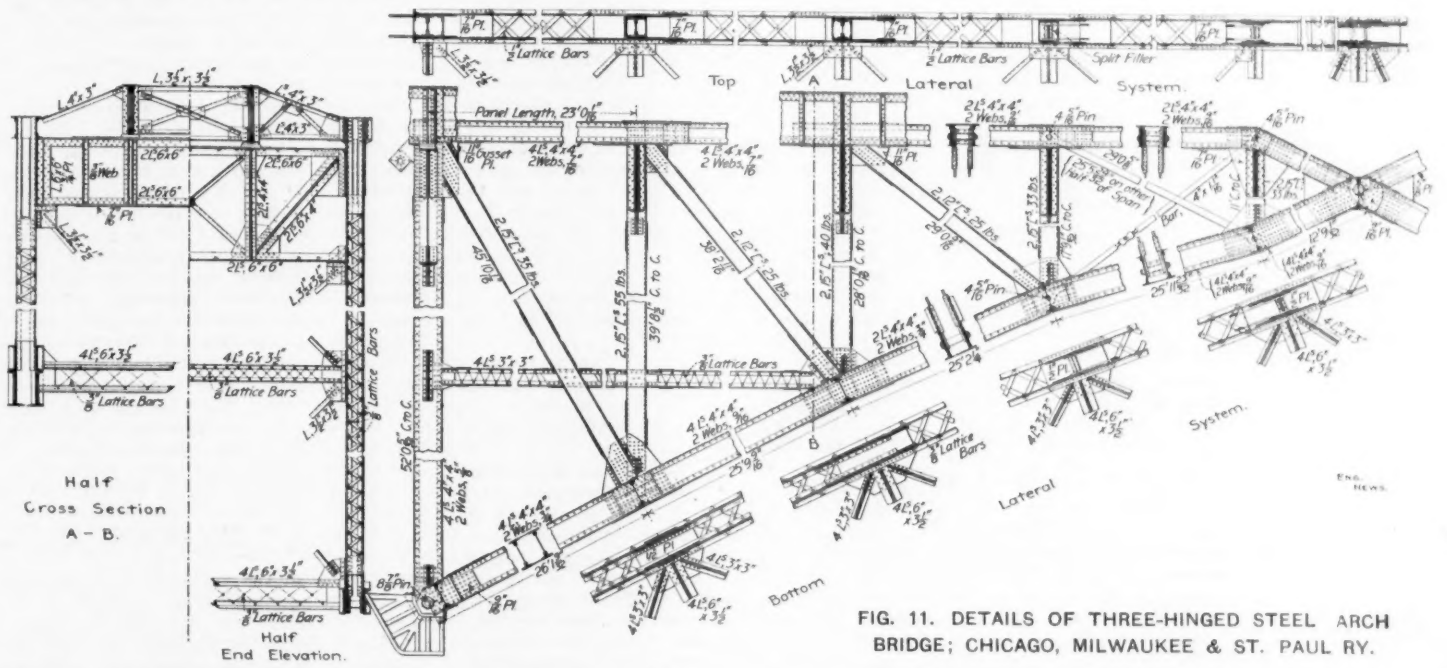


FIG. 11. DETAILS OF THREE-HINGED STEEL ARCH BRIDGE; CHICAGO, MILWAUKEE & ST. PAUL RY.

1,800-FT. CANTILEVER BRIDGE OVER THE ST. LAWRENCE RIVER AT QUEBEC, CANADA.

The longest span bridge in the world is the Quebec Bridge now under construction across the St. Lawrence River, about seven miles up stream from the city of Quebec. This bridge has a channel span of 1,800 ft., or a clear span 90 ft. longer than the main span of the great Forth Bridge in Scotland. At the present time the substructure for this bridge is about completed, and the American contractors for the superstructure, the Phoenix Bridge Co., of Phoenixville, Pa., are manufacturing the steel work for the superstructure. A fairly good notion of the size and appearance of this great structure are had from Fig. 12, which is reproduced from the "Canadian Engineer." In an early issue we shall describe the substructure of the Quebec Bridge in some detail, and later a full description of the superstructure will be published. At the present time, therefore, we shall give only the main structural features of the great work now being carried out by our Canadian neighbors.

The Quebec Bridge is being constructed over the narrowest portion of the St. Lawrence River between Montreal and Quebec, about 6½ miles west of the commercial center of the latter city. The river at this point flows between high rocky cliffs on both sides, the waterway being about 1,900 ft. at low tide, and about 2,500 ft. at extreme high tide, the tidal rise varying from a minimum of about 14 ft. to a maximum of 20 ft. The maximum depth of water in the channel is about 180 ft., the tidal current being 6 to 7 knots an hour. The depth of water decreases rapidly towards the main river piers, where at extreme low tide it is 10 ft. deep, the maximum depth at high tide being 30 ft. These piers are 1,800 ft. apart between centers.

The channel will be crossed with a suspended span and two cantilever arms, making an unsupported structure 1,800 ft. long between center of main piers, which will be the longest span in the world. The length of anchor arms on each side of the main span will be 500 ft., with one approach span of 220 ft. at each end between anchor piers and terminal abutments. The total length of the structure, including abutments, will be 3,300 ft. A clear headway of 150 ft. between

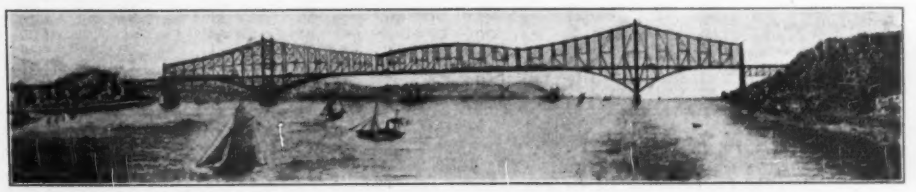
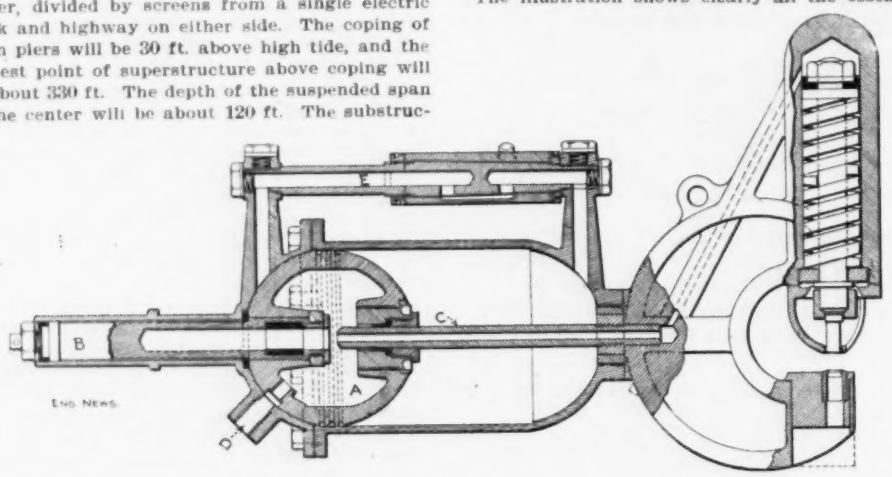


FIG. 12. CANTILEVER BRIDGE OF 1,800-FT. SPAN AT QUEBEC, CANADA.
E. A. Hoare, Chief Engineer; Phoenix Bridge Co., Phoenixville, Pa., Contractors for Superstructure.

underside or lower chords and highest tides for vessels in the channel will be provided. There will be a clear width of 62 ft. 6 ins. between trusses for two steam railway tracks in the center, divided by screens from a single electric track and highway on either side. The coping of main piers will be 30 ft. above high tide, and the highest point of superstructure above coping will be about 330 ft. The depth of the suspended span at the center will be about 120 ft. The substructure will consist of two main piers, two anchor piers and two abutments.

Mr. E. A. Hoare is Chief Engineer, and Mr. Theodore Cooper, M. Am. Soc. C. E., is Consulting Engineer of the bridge. The contractor for the substructure is Mr. M. P. Davis, of Ottawa, Ontario, and the contractor for the superstructure is the Phoenix Bridge Co., of Phoenixville, Pa.



DETAILS OF PORTABLE PUNCH OPERATED BY COMBINED AIR AND HYDRAULIC PRESSURE.
F. F. Slocomb & Co., Wilmington, Del., Builders.

STANDARD CROWNS FOR STREET PAVEMENTS AT OMAHA, NEB.

The accompanying table and diagram of standard street crowns for various classes of pavements, on different grades, was kindly sent to us by Mr. Andrew Rosewater, M. Am. Soc. C. E., City Engineer of Omaha, Neb. The formulas used in constructing the table were: For asphalt,

$$c = \frac{w\ (100 - 4\ f)}{5{,}000};$$

for brick, stone, wood and macadam,

$$c = \frac{w\ (100 - 4\ f)}{6{,}000};$$

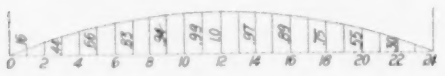


Diagram Illustrating Form of Street Crowns at Omaha, Neb.

where

c = crown of pavement in feet;
w = distance between curbs in feet;
f = feet fall per 100 ft. of street.

Directions for the widths of gutters are as follows: Where the crown is less than 0.5-ft. make the gutter 0.5-ft., and where it is 0.7-ft. make the gutter 0.7-ft., and for intermediate crowns make the gutter equal the crown.

Standard Crowns for Street Pavements at Omaha, Neb.

Distance between curbs.	Grade of street. Brick, stone, wood and macadam, in ft. Per cent. Level.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
20 ft.	.33	.32	.31	.29	.28	.27	.25	.24	.23	.21	.20	.19	.17	.16	.15
25 "	.42	.40	.38	.37	.35	.33	.32	.30	.28	.27	.25	.23	.22	.20	.18
30 "	.50	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26	.24	.22
35 "	.58	.56	.54	.51	.49	.47	.44	.42	.40	.37	.35	.33	.30	.28	.26
40 "	.67	.64	.61	.59	.56	.53	.51	.48	.45	.43	.40	.37	.35	.32	.29
45 "	.75	.72	.69	.66	.63	.60	.57	.54	.51	.48	.45	.42	.39	.36	.33
50 "	.83	.80	.77	.73	.70	.67	.63	.60	.57	.53	.50	.47	.43	.40	.37
55 "	.92	.88	.84	.81	.77	.73	.70	.66	.62	.59	.55	.51	.48	.44	.40
60 "	1.00	.96	.92	.88	.84	.80	.76	.72	.68	.64	.60	.56	.52	.48	.44
65 "	1.08	1.04	1.00	.95	.91	.87	.82	.78	.74	.69	.65	.61	.56	.52	.48
70 "	1.17	1.12	1.07	1.03	.98	.93	.89	.84	.79	.75	.70	.65	.61	.56	.51
75 "	1.25	1.20	1.15	1.10	1.05	1.00	.95	.90	.85	.80	.75	.70	.65	.60	.55
80 "	1.33	1.28	1.23	1.17	1.12	1.06	1.01	.96	.91	.85	.80	.75	.69	.64	.59

Distance between curbs.	Grade of street. Asphalt, in ft. Per cent. Level.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
20 ft.	.40	.38	.37	.35	.34	.32	.30	.29	.27	.26	.24	.22	.21
25 "	.50	.48	.46	.44	.42	.40	.38	.36	.34	.32	.30	.28	.26
30 "	.60	.58	.55	.53	.50	.48	.46	.43	.41	.38	.36	.34	.31
35 "	.70	.67	.64	.62	.59	.56	.53	.50	.48	.45	.42	.39	.36
40 "	.80	.77	.74	.70	.67	.64	.61	.58	.54	.51	.48	.45	.42
45 "	.90	.86	.83	.79	.76	.72	.68	.65	.61	.58	.54	.50	.47
50 "	1.00	.96	.92	.88	.84	.80	.76	.72	.68	.64	.60	.56	.52
55 "	1.10	1.06	1.01	.97	.92	.88	.84	.79	.75	.70	.66	.62	.57
60 "	1.20	1.15	1.10	1.06	1.01	.96	.91	.86	.82	.77	.72	.67	.62
65 "	1.30	1.25	1.20	1.14	1.09	1.04	.99	.94	.88	.83	.78	.73	.68
70 "	1.40	1.34	1.29	1.23	1.18	1.12	1.06	1.01	.95	.90	.84	.78	.73
75 "	1.50	1.44	1.38	1.32	1.26	1.20	1.14	1.08	1.02	.96	.90	.84	.78
80 "	1.60	1.54	1.47	1.41	1.34	1.28	1.22	1.15	1.09	1.02	.96	.90	.83

A PUNCH OPERATED BY COMBINED AIR AND HYDRAULIC PRESSURE.

We illustrate in the accompanying cut a sheet metal punch whose construction and mode of operation present distinctly novel features. Briefly described, it is a portable punch operated by air and hydraulic pressure coacting by means of a special mechanism to drive a punch plunger. The new tool is known as the Caskey pneumatic punch and is being made and sold by F. F. Slocomb & Co., of Wilmington, Del.

The illustration shows clearly all the essential structural features of the new punch. As will be seen, the punch consists of a cylinder in which works a spherical hollow piston. This piston carries a tail rod which works through the rear end of the cylinder, and, also, slides on a stationary hollow rod extending inward from the cylinder head. This stationary hollow rod connects with a passage leading to the cylinder of the punch plunger. The piston and its hollow tail rod, the stationary hollow rod, and the passages leading to the punch plunger cylinder are kept filled with oil. The pressure of this contained oil in the punch plunger piston, when the air cylinder piston is actuated by air pressure, operates the punch. The working of the several parts described to bring about this action are as follows:

Referring to the illustration, which is a longitudinal sectional elevation of the punch, A, is the hollow ball piston carrying the tail rod or intensifier, B, and sliding on the stationary hollow rod, C. When the piston is at the rear point of its stroke the end of the rod, C, is approximately at its center. To drive the piston forward air is admitted to the cylinder at D. At an early period in the forward movement of the piston the rod, C, telescopes into the tail rod, B, and seals communication between its cavity and the interior of the piston. As the movement forward of the piston continues the entire air pressure behind it is concentrated upon the column of oil contained in the rod, C, and the passage leading to the punch ram chamber. When the piston has completed its working stroke a hand valve is turned in the by-pass, E. This admits the air to the other end of the cylinder and equalizes the air pressure on the two sides of the piston, but the area of the rod, C, being less than that of the tail rod, B, a greater force is exerted on the forward face of the piston than on the rear face, and it is driven back into position for another forward stroke. The punch plunger is meanwhile returned to a similar position by the coiled spring.

From the preceding description of the operation of the punch it will be seen that one cylinder full of air accomplishes both the forward and the return stroke of the piston. Further, the volume of oil in the piston, its rods and the connecting passageways being just sufficient to depress the punch a certain distance, as soon as the hole is punched no further downward motion of the punch is possible, and all jarring and undue strain is prevented. The makers point out further that, owing to the peculiar construction and arrangement of the ball piston and the parts connected with it, it is impossible for any air to get into the high pressure passages, unless the oil level in the piston is permitted to fall below the top of the opening in the tail rod, when the piston must be refilled at once.

The punch described is made in a number of sizes for plate work, and is also made with a special auxiliary stroke attachment for work on structural shapes or wherever it is necessary to clear any projection. The "auxiliary stroke" is actuated directly by air pressure admitted to the auxiliary piston chamber, and may be given any travel desired, but after clearing the projection the punch is operated as described above. The punch is portable, and can be operated by one man.

THE FAILURE OF A WAREHOUSE FLOOR IN MINNEAPOLIS, MINN.

We briefly noted in our last issue the failure of a warehouse floor in Minneapolis, Minn., Nov. 7, fortunately without loss of life or injury to persons. We are able to give below further particulars of the accident, and, through the courtesy of Mr. C. A. P. Turner, M. Am. Soc. C. E., of Minneapolis, we are also enabled to present some sketches of the construction.

The building in which the failure occurred is a six-story warehouse located on Third St., S., near Seventh Ave., in Minneapolis; it was built last spring from plans of a firm of architects located in Minneapolis. It is occupied by the Bement-Darling Co., dealers in wagons and farm implements, and is used by them as a storehouse for the goods they deal in. A portion of the upper two (fifth and sixth) floors was given up to the storage of groceries; in particular, a quantity of sugar in sacks occupied a section of the sixth floor. This latter section gave way under its load, on the date mentioned, and in falling carried away the corresponding sections of the floors below, down to the ground. In a description of the failure contained in the Minneapolis "Tribune" of Nov. 8, we find the following statements:

> For the past two days there was a warning of the impending accident in the bulging of some of the upper floors. It was thought that the supports of the floor beams against the wall of the adjoining building were giving way, and an examination was made Thursday (Nov. 6) afternoon by the architect, who gave it as his opinion that the building was safe.

The article in the "Tribune" goes on to state that on the morning of the accident two of the leading officers of the company occupying the building "went to the fifth floor to look over the situation while awaiting the arrival of the architect and contractor," when suddenly a portion of the floor above gave way, etc. The portion of floor which fell is stated to measure about 22 ft. by 70 ft. As to the cause of the accident, the following statement is made:

> The cause of the accident was the breaking of the stirrups or braces set in the brick wall to support the heavy floor joists. These gave way on the sixth floor. . . .
>
> The architect stated that the amount of weight per square foot allowed was not less than 250 lbs. The weight necessary, it is estimated, to cause the floors to give way is 1,500 lbs. per sq. ft. The manager of the company stated that at the place where the stirrupts gave way the weight did not exceed 220 lbs., while the average over the building was not more than 150 lbs.

The view expressed in the above, that a floor-beam stirrup hanger gave way and caused the floor to fall, is corroborated by all accounts we have received. The load on the floor at the time has been determined quite definitely. Some 2,400

sacks of sugar, each 100 lbs. in weight, were piled, to a depth of five or more, on an area of about 22 by 60 ft., practically the section of floor that fell. The unit live load over this area was thus about 180 lbs.; to this must be added some 20 to 25 lbs. for the dead weight of the floor plank and joist. The total load on the joist, therefore, was close to 200 lbs. per sq. ft. As this is considerably less than the load which the floor was designed to carry with safety, it is important to determine how the failure was brought about. It will be of interest to examine the construction of the floor.

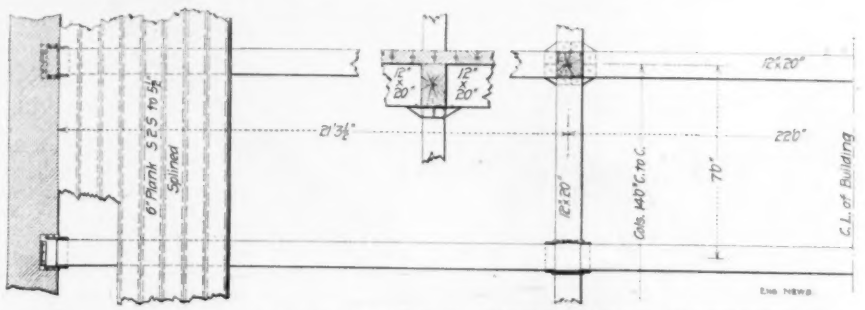


FIG. 1. FLOOR CONSTRUCTION USED IN BEMENT-DARLING WAREHOUSE, MINNEAPOLIS, MINN.

A typical portion of the floor with its connection to column and wall is shown in the accompanying drawing, Fig. 1. The walls of the building are of brick; the entire interior construction, including posts, beams and flooring, is of wood. The posts are spaced 14 ft. apart in one direction and 22 ft. apart transversely, and support the main floor beams, spanning 14 ft. Joists are spaced 7 ft. apart on centers, and a plank floor is spiked over them. Beams and joists are of like section, 12 ins. wide by 20 ins. deep, and are of sound fir timber. Where they connect to the columns they rest on cast-iron post caps. The joists, which are flush on top with the beams, are hung to them by steel stirrup hangers; similar hangers built into the walls support the wall ends of the joists, which latter do not project into the brickwork. The floor is a single thickness of 6-in. plank dressed to 5½ ins. and splined together.

Calculation shows that the beams, joist and floor plank will safely carry their specified load of 250 lbs. per sq. ft. Indeed, the flooring, figured 5½ ins. thick on a span of 7 ft., would carry with safety a load of over 800 lbs. per sq. ft., at a maximum fiber stress of 1,000 lbs. per sq. in. The capacity of the beams and joists is only about one-quarter of this; but taking into account the fiber stress permissible for this quality of timber, they are fully sufficient for a safe load of 250 lbs. per sq. ft.

On the other hand, when the stirrup hangers, on which the floor is hung, are examined, a serious deficiency in strength becomes evident. These hangers are shown in Fig. 2, herewith, which is drawn from some sketches sent us by Mr. Turner, as already referred to. The style of hanger used as a wall connection differs somewhat from that used to connect the joist to the beams. Both styles are shown in Fig. 2. The latter is the simpler form of hanger; it consists of a single piece of steel bent to form a shelf for the joist; the ends of the hanger hook over the main beam and are spiked down. The hanger used as a wall connection is exactly similar to the preceding, but has in addition a wall-bearing plate riveted to the lower side of the hooked ends, and a small anchor-angle riveted to the rear edge of the bearing-plate. The dimensions of the several parts of the hangers are shown on our drawing. The metal of the hanger body is ¼-in. thick; the lower shelf, on which the 12 by 20-in. timber rests, is 4 ins. wide. The wall-bearing plate is 8 ins. wide by ¼-in. thick, by about 16 ins. long. It is riveted to the 2-in. flange of the hanger body by four ⅜-in. rivets.

The elements of weakness that will be apparent in these hangers are given increased importance by reference to a sketch, also shown in Fig. 2, which represents the material of the hanger body before it is bent into shape, and illustrates the process of manufacture of the hangers. The original material seems to have been a 4-in. structural steel angle; the legs are sheared to the shape shown, and the one flange is completely blocked out for 12 ins. at the portion intended to form the seat for the timber. The sides are bent up, forming a sharp corner angle, and their upper portions are then bent over to form the hook ends. In regard to the probable effects of such a method of manufacture on the material, we would point out only the sharp corner formed at the bottom of the side legs (by cold bending?), together with the abrupt change in section and the junction of two sheared edges, occurring at the same points.

A little figuring reveals some noteworthy points as to the strength of the hangers. The joist which they carry would transmit to the hanger, under the full load of 250 lbs. per sq. ft., a reaction amounting to $7 \times 11 \times 250 = 19{,}250$ lbs. This is to be carried on a shelf 4 ins. wide, ¼-in. thick, and 12 ins. between supports. Considered as a uniformly distributed load this reaction would produce a bending stress in the shelf about ten times the ultimate strength of the steel. The shelf will, therefore, be bent down so that the joist bears only along the side edges. Under the great load the timber of the joist would crush at the corners and the bottom of the hanger would become virtually a suspension band. The stress in this band, practically pure tension, is also excessively great; with a sag of 1 in., this tension would amount to nearly 30,000 lbs., on a section of 1 sq. in. Almost equally open to criticism is the bearing of the hook ends of the hanger on the main floor beam. An area of 24 sq. ins. must carry a load (even if the hook ends were stiff enough to distribute this load) of 19,000 lbs. The effect on the upper edge of the main floor beam may be imagined. The wall hanger is in similar condition; the distributing effect of the ¼-in. bearing-plate is insufficient to prevent the hanger from crushing down in the brickwork of the wall, especially at the front edge. Any calculations on these matters here is superfluous.

The conditions actually resulting are well pictured in the sketches (in Fig. 2) of the action of the hangers under the load. It will be remembered that the "failure" loading was one-fifth less than that figured just above, so that the actual load on the hangers was only about 15,000 lbs. each. As is indicated, the lower shelf of the hanger sagged down, crushing the timber, while the upper bearing surfaces of the hanger crushed down into the brickwork. The passage quoted above from the "Tribune" now becomes quite clear, that for two days before the failure "there was a warning of the impending accident in the bulging of some of the upper floors," which points directly to the sagging of the floor joists in their distorted hangers.

In this state of affairs, however, a new source of danger arises. We have not in the preceding referred to the bend of the hanger where the latter passes into the brickwork (or over the beam, respectively); if this point be examined, dangerous conditions of stress will be found. The simple shear on the section under full load is quite up to its capacity; the bending stress, under any reasonable assumption, is probably excessive, even before any deformation occurs. When the hanger distorts and crushes the brickwork, the bending stresses are aggravated, while in addition a direct tension is superimposed. The result is to be foreseen, especially if it be remembered that the section in question is at a point where the metal has already been bent in the process of manufacture.

As a matter of fact, the evidence available seems to indicate that the initial failure occurred at this point of a hanger under the heavily loaded part of the sixth floor. One hanger gone and the load of its joist thrown suddenly upon the neighboring hangers, there was nothing to keep these already dangerously strained details from also giving way, and a successive failure was the direct consequence. It appears quite natural from this that the step-by-step collapse of the floor was not arrested until practically the entire heavily loaded section of floor had gone down.

It may be added here, as a matter of interest, that in the lower floors, which were broken down by the impact of the heavy mass of ruins from above, the hangers failed in a different manner.

Instead of breaking at the upper bend, they failed at the junction of the bottom shelf with the side of the hanger; in most cases the shelf or bottom plate was straightened down vertically as though it were a strap hinged to one side. These hangers, of course, were under a comparatively small loading, and probably had not suffered any deformation at the time the failure occurred. The sudden shock of the falling mass caused a different distribution of stress than in case of steady load, like that which broke down the sixth floor; for reasons suggested previously the section where the hanger bent up from the bottom shelf to form the sides was most unfavorably disposed to resist any sudden application of load, and the failure here was a natural result.

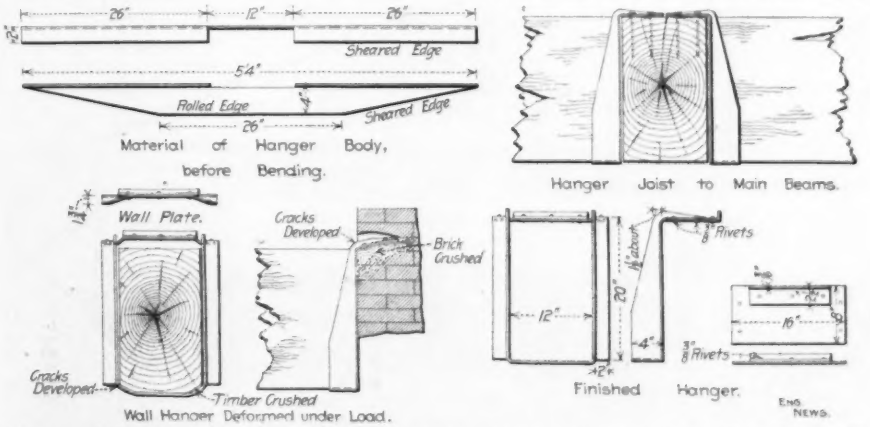


FIG. 2. STEEL JOIST HANGERS FOR 12 × 20-IN. JOIST, AS USED IN BEMENT-DARLING WAREHOUSE.

THE SUBMARINE BOAT, "GRAMPUS," recently received an unofficial trial in San Francisco Bay. The trial was wholly satisfactory, the boat developing a 9-knot speed afloat. The government has contracted for 15 Holland submarine boats of the "Grampus" and "Adder" type. Four have now been built. The crew of these boats consists of a navigator, engineer, electrician, gunner and three machinists—seven in all.

RECENT TYPES OF CRANES.

The crane derrick, or horizontal boom derrick, has come into use quite extensively in recent years at steel works and structural works where material of considerable length has to be handled. We illustrate herewith one of these cranes which has been erected during the present year for the Lukens Iron & Steel Co. in its storage yard at New Orleans, La. The vertical mast (the lower part of which is formed of two legs) is mounted on a pivot or turntable carrying a platform, on which is placed the operating machinery, enclosed in a cabin. The top of the mast may be supported by one or more rigid braces, or by a system of guy cables. In the derrick here illustrated there is only one brace, which is stiffened by a pair of truss rods, being of such length and inclination as not to interfere with the boom. The boom is a timber 12 × 12 ins., the heel of which projects beyond the mast and carries the backstays. It is rigidly attached to the mast, both revolving together. The boom is supported by four stay rods from the head of the mast. The upper edges are faced with angle irons, upon which run the wheels of a traveling trolley, from which the hoisting block and hook are suspended. The trolley is traversed by means of a wire rope running over a sheave under the head of the boom, and the hoisting and traversing ropes are led down the mast to the drums in the cabin. The mast is 53 ft. high and the boom is 23 ft. above the ground, with a length of 60 ft. The hoisting capacity is 3 tons, and the boom can be swung through an angle of 270°. All the operations of hoisting, traversing and swinging are effected by a 10-HP. electric motor in the operator's cabin. The illustration shows a long I-beam suspended from the boom.

A somewhat larger derrick of this kind, built in 1899 for the Jones & Laughlin Co.'s yard at Chicago, has a 60-ft. mast and a 60-ft. boom, 12 × 16 ins.; its hoisting capacity is 5 tons, and it is operated by a 20-HP. steam engine. This has two stiff legs or supports for the mast, and can be revolved through a complete circle. These derricks are not ordinarily made of large capacity, the limit being about 5 tons at 65 ft. radius. The same is true of the tubular guy derricks, which are used for similar work, but have the boom pivoted at the foot of the mast so as to have a variable reach, regulated by a topping-lift connecting the heads of the mast and boom. These latter derricks, which have been illustrated in our columns, have the mast and boom built of 6-in. steel tubing, stiffened by truss rods, while the head of the mast is supported by guys. These derricks do not as a rule exceed 10 tons in hoisting capacity. One of this capacity, built for the Harrisburg Foundry & Machine Co., of Harrisburg, Pa., has a 50-ft. mast and a 44-ft. boom, with a radius of 10 to 40 ft., and revolves through a complete circle, being operated by a 15-HP. steam engine.

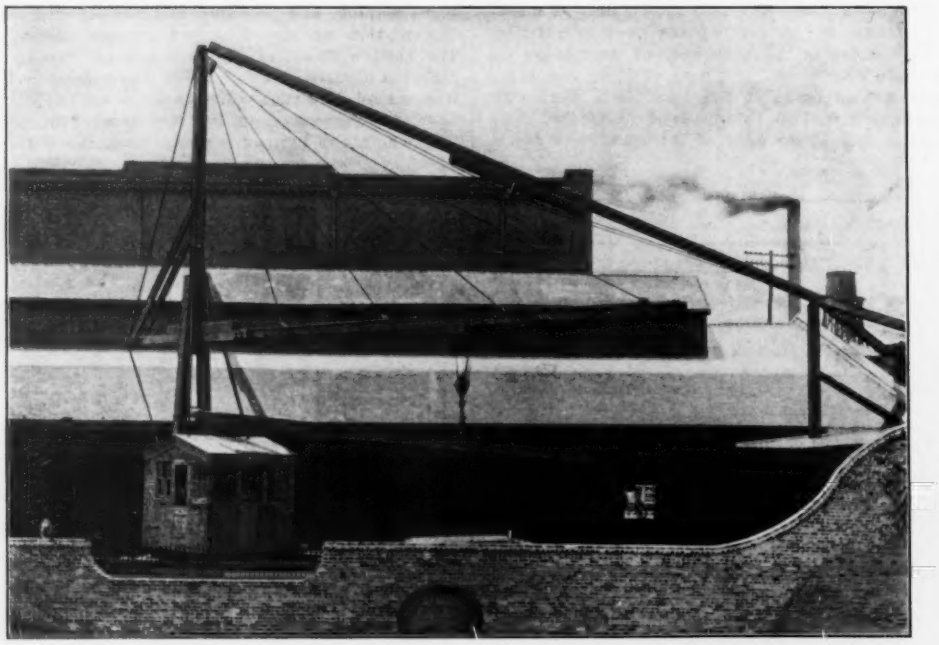


FIG. 1. 5-TON DERRICK CRANE FOR THE LUKENS IRON & STEEL CO.
American Hoist & Derrick Co., St. Paul, Minn., Builders.

The locomotive crane has come to be a very important tool at many manufacturing plants where heavy pieces are handled. Fig. 2 shows a large machine of this type built for the Lake Superior Power Co., whose works at Sault Ste. Marie were described in our issue of Jan. 9, 1902. It was built for the use of the Algoma Steel Co. (one of the associated companies) in constructing the new steel plant on the Canadian side, and is now used for general work, loading and unloading cars and transferring material about the yards and shops.

FIG. 2. 30-TON LOCOMOTIVE CRANE FOR THE LAKE SUPERIOR POWER CO.
American Hoist & Derrick Co., St. Paul, Minn., Builders.

A special feature in this crane is the arrangement of the machinery. In many such cranes the machinery is carried in triangular or A-shaped side frames, and the topping-lift which supports the head of the boom is attached to an upright frame at the heel of the boom, the frame being supported by tie-rods or tension-bars anchored to the rear of the bed of the machine. In the present machine, however, a much stronger support is afforded by the two tall A-frames, which are independent of the machinery and are connected at their heads by a heavy cross piece to which the pulleys for the topping-lift are attached. Each leg is composed of a pair of steel channels, set back to back, with lateral bracing between the legs. The boom is composed of a pair of steel channels connected by bracing and reinforced by plates near the head. The machinery has all the gearing arranged in the same horizontal plane, and all the operations of raising and lowering the load, raising and lowering the head of the boom, swinging the machine and moving it along the track are controlled by levers at the front of the platform, where the man has a good view of the load.

The machine is carried on four wheels, the axles of which are journaled in a heavy cast-iron frame, upon which is a circular rack of large diameter for swinging the upper frame which carries the machinery, boiler and boom. The length of the boom is 30 ft., with a radius of 10 to 35 ft. and a height of 36 ft. to 15 ft. The hoisting capacity is 15 tons, and the machine can be swung through a complete circle. The machinery is driven by a 30-HP. steam engine, with two cylinders 8¼ × 10 ins., and steam is supplied by a vertical boiler 4 ft. 7 ins. diameter and 7 ft. 1 in. high. The crane has a total weight of 97,000 lbs., and can be traversed along the track by bevel gearing at a speed of 600 ft. per minute. A similar but more powerful crane has recently been built for the new Milwaukee works of the Allis-Chalmers Co. This is of 20 tons capacity, with a 29-ft. boom, having a radius of 10 to 32 ft. and a height of 34 to 15 ft., according to the radius. It is driven by a 50-HP. engine, with cylinders 10 × 12 ins., and has a boiler 5 ft. diameter and 8 ft. high. Its total weight is 106,000 lbs.

All the machines above described were built by the American Hoist & Derrick Co., of St. Paul, Minn., and we are indebted to that firm for the photographs herewith reproduced.

STREET CLEANING STATISTICS FOR CITIES ABOVE 3,000 POPULATION IN THE UNITED STATES.

By A. Prescott Folwell, M. Am. Soc. C. E.*

For the intelligent study of municipal problems engineers and city officials require a knowledge of what other cities have done and how they have done it, and any compendium of facts along these lines, giving data both full and compactly arranged in logical order, is of great assistance to them. "The Municipal Year Book" furnishes such

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a compendium, probably the most valuable, dealing with American cities, which has ever been made. The detailed statistics given therein are useful for an exhaustive study of any of the various public works and services treated of; but the summaries presented in the Introduction contain all the information needed for many purposes, and save to the investigator the great loss of time which would be required for extracting the same from the detailed statements. The writer has realized this more thoroughly since his recent efforts to prepare a brief report on Street Cleaning in the United States. This is one of the few branches of municipal service of which no summary is given in the "Year Book;" but since the information is contained in the detailed reports, a tabulation thereof was prepared, and is herewith presented as probably of interest to others, also.

In these tables the grouping of States is the same as that adopted in the "Year Book;" the cities are further divided into eight groups according to population. The first three columns give the numbers of cities of the various classes which clean their streets by day labor (city employees) only; the fourth column, those in which this work is done both by city employees and by contractors; the fifth, sixth and seventh, those in which the cleaning is done by contract only. The first and fifth give the number of those in which hand labor only is employed; the second and sixth, those in which machines alone are used; and the third and seventh, those in which both are employed, and also those from which the reports were indefinite, merely stating that the work was done "by day labor" or "by contract." Of the 24 cities which fall under the fourth column, in which the cleaning was done both by the city and by contractors, hand labor alone was used in six, machines alone in six, and both methods in twelve. It was thought unnecessary to expand the tables by making separate columns for these.

In the last five columns is shown the disposal made of the street sweepings. Under the head of Filling are included all those places which report "dumping," "on vacant lots," "along the river bank," etc., it being assumed that filling of low ground was effected by all these. Under Fertilizer are included those selling or giving the material to farmers. Under Filling and Fertilizer are classed such as report the sweepings "sold" or "given away" only, as well as those specifying that it is used for both filling and fertilizing. Under Carted Away are classed only such as use these words in their reports. The same is true of those classified as dumping into water; the water being designated as the lake, river, sound or bay, in the separate reports. The data of disposal are unfortunately indefinite, the 122 places classified under either Filling and Fertilizer or Carted Away probably belonging under one of the first two columns; while it is probable that some of the 24 places dumping the sweepings in water do so with the object of "making land" by filling in. This uncertainty seems unavoidable when we consider that in many cities all these methods are employed either contemporaneously or successively during a single year.

It is probable that there are some inaccuracies in these tables, as well as misleading statements. This may be due to lack of definite information on the part of those reporting or carelessness or indefiniteness in expressing themselves; to the difficulty of classifying many of the cases; and to actual errors in preparing the tables. The last the writer has taken some pains to avoid, but cannot claim infallibility. The indefiniteness may be due to some such condition as a general cleaning of the streets by contract except around certain municipal buildings, where city employees perform the work; or a general cleaning by the city, except that the snow is removed by contract. Either of these cases might be classed as cleaned by both day labor and contract, although much the larger part of the work is done in one way only. Again, a city which uses machines on all streets might be reported as using hand labor also because of the hand brooms used in cleaning gutters, and in gathering the sweepings into piles for carting away. The latter seems to be the more common class of indefiniteness, as is seen by comparing these totals with those given by the Department of Labor in its report for 1901 (the reports ending in some cities with Dec. 31, 1900, and in others not until June 30, 1901). This report does not include cities of less than 30,000 inhabitants. Of those included the total numbers reported as cleaning by Day Labor, by Contract, and by Both, differ from those given in the "Year Book" in but two cases. Under Day Labor, however, the Department reports 15 by hand, 9 by machine, and 90 by both; as against 25 by hand, 14 by machine, and 77 by both in the "Year Book." Under Contract the Department report gives 2 by hand, 1 by machine and 8 by both; while the "Year Book" gives 2 by hand, 2 by machine and 5 by both. It is possible that some or all of these differences may be due to actual changes of method between the times of collecting the data.

Either report shows that the number of cities of more than 30,000 population using both hand and machine sweeping is two or three times as great as the total of those using either separately, comparatively few using machines alone.

If we consider all places of over 3,000 population we find, as might be expected, that the proportion using machines decreases as the size of the town decreases, as does also the proportion of those cleaning by contract. In the matter of disposal, the size of the town seems to have little influence, except that the sweepings are used for filling in a smaller percentage of the towns of less than 30,000 population than of the larger ones.

Summing up for all towns and cities of more than 3,000 population which reported (these constituting 90% of the total number): 92% cleaned their streets by day labor alone, 6.3% by contract alone, and 1.8% by both plans; 69.5% cleaned by hand, 6.2% by machine, and 24.3% by both methods:

STREET CLEANING STATISTICS FOR PLACES OF 3,000 POPULATION AND OVER IN THE U. S.
(Summarized from Detailed Reports in "The Municipal Year Book.")

Population.	Day labor. Hand.	Day labor. Machine.	Day labor. Both.*	Both day labor and contract.	Contract. Hand.	Contract. Machine.	Contract. Both.*	Disposal. Filling.	Disposal. Fertilizer.	Disposal. Filling and fertilizer.	Disposal. Carted away.	Disposal. D'mped in water.
NEW ENGLAND STATES: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.												
3,000 to 4,000	16	..	2	1	..	.	..	9	1	..	..	..
4,000 " 5,000	17	1	4, (1)	..	..	..	..	13	3	..	..	..
5,000 " 10,000	53	2	14	..	1	..	..	34	4	3	..	..
10,000 " 20,000	22	1	11	..	..	1	..	21	4	1	..	..
20,000 " 30,000	7	..	6	..	..	..	..	7	2	2	..	..
30,000 " 40,000	1	..	7	..	..	..	..	5	2	..	..	..
40,000 " 50,000	2	..	1	..	..	..	..	3	..	..	..	..
More than 50,000	2	1	11, (1)	..	..	..	..	10	1	..	2	..
MIDDLE STATES: New York, New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia.												
3,000 to 4,000	55	..	8, (2)	..	..	..	(1)	34	6	2	3	..
4,000 " 5,000	36	..	7, (1)	1	..	1	1	28	4	6	2	..
5,000 " 10,000	57	2	20	4	3	2	2, (1)	49	10	6	5	..
10,000 " 20,000	32	1	11	1	3	1	..	27	2	6	1	..
20,000 " 30,000	15	1	2	..	..	1	..	11	1	3	1	..
30,000 " 40,000	2	1	7	..	..	..	..	7	1	2	..	..
40,000 " 50,000	1	..	1	..	..	..	..	1	1	..	..	..
More than 50,000	2	..	14	3	1	..	5	16	1	3	1	..
SOUTH ATLANTIC STATES: Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida.												
3,000 to 4,000	26	..	1, (2)	..	..	..	..	7	..	2	13	..
4,000 " 5,000	16	..	4, (1)	..	..	..	..	8	2	..	6	..
5,000 " 10,000	21	..	1, (3)	..	1	..	1	10	3	2	4	..
10,000 " 20,000	6	1	12	..	1	..	..	8	5	4	1	..
20,000 " 30,000	1	1	4	..	..	..	..	2	1	2	1	..
30,000 " 40,000	1	..	..	..	..	..	..	2	..	..	..	..
40,000 " 50,000	..	1	..	..	..	..	..	1	1	..	..	..
More than 50,000	..	..	4	..	..	..	..	1	1	2	..	..
SOUTH CENTRAL STATES: Alabama, Mississippi, Louisiana, Tennessee, Kentucky.												
3,000 to 4,000	22	3	1, (1)	..	3	..	..	9	..	..	..	1
4,000 " 5,000	14	..	1	..	1	..	..	8	..	..	..	..
5,000 " 10,000	19	..	3, (1)	..	..	1	..	8	1	..	..	1
10,000 " 20,000	3	..	2	1	1	1	..	4	..	..	..	3
20,000 " 30,000	1	..	1	..	..	..	..	2	..	..	..	..
30,000 " 40,000	2	..	3	..	..	..	..	3	2	..	..	..
40,000 " 50,000	..	..	1	..	..	..	..	1	..	..	..	..
More than 50,000	1	1	2	..	..	..	..	2	..	..	..	..
NORTH CENTRAL STATES: Ohio, Indiana, Michigan, Illinois, Wisconsin.												
3,000 to 4,000	58	5	8	1	3	2	..	45	1	2	..	3
4,000 " 5,000	35	1	6, (1)	..	1	2	1	21	2	4	..	1
5,000 " 10,000	81	5	29, (1)	3	2	4	4, (1)	75	11	7	2	..
10,000 " 20,000	29	5	27	2	..	1	1	47	5	4	1	..
20,000 " 30,000	7	2	11	..	..	..	..	19	1	..	..	..
30,000 " 40,000	5	..	3	..	..	..	..	8	..	..	..	..
40,000 " 50,000	1	..	3	..	..	..	..	2	..	..	..	..
More than 50,000	1	8	..	1	..	2	..	10	1	1	..	..
NORTHWESTERN STATES: Iowa, Minnesota, Kansas, Nebraska, S. Dakota, N. Dakota, Wyoming, Montana.												
3,000 to 4,000	29	1	2	2	2	1	..	22	..	2	..	..
4,000 " 5,000	19	..	(1)	..	1	1	..	11	..	..	..	2
5,000 " 10,000	32	2	5, (1)	1	..	1	..	24	1	..	1	..
10,000 " 20,000	9	1	7, (1)	..	..	..	.	10	..	..	..	2
20,000 " 30,000	2	1	4	..	..	..	..	6	..	..	..	..
30,000 " 40,000	2	1	2	..	..	..	..	4	..	..	..	..
40,000 " 50,000	1	..	..	..	..	..	..	1	..	..	..	..
More than 50,000	1	..	4	1	..	..	..	5	..	..	..	..
SOUTHWESTERN STATES: Missouri, Arkansas, Texas, Indian Territory, Oklahoma, Colorado, New Mexico.												
3,000 to 4,000	27	..	(2)	..	5	..	..	10	..	..	..	1
4,000 " 5,000	17	..	..	..	2	..	..	8	..	..	1	1
5,000 " 10,000	26	..	2, (1)	1	5	..	..	17	..	1	3	1
10,000 " 20,000	9	..	3	..	..	..	..	10	..	..	..	1
20,000 " 30,000	3	1	1	..	.	..	..	4	..	..	..	1
30,000 " 40,000	..	1	1	..	..	..	..	1	..	..	..	..
40,000 " 50,000	..	..	2	..	..	..	..	2	..	..	..	..
More than 50,000	..	..	5	..	..	..	..	1	..	..	..	3
PACIFIC STATES: Washington, Oregon, California, Arizona, Nevada, Utah, Idaho, Alaska.												
3,000 to 4,000	15	..	(1)	..	3	..	..	10	1	..	2	1
4,000 " 5,000	8	..	1	..	1	..	..	5	1	..	2	1
5,000 " 10,000	10	..	2, (1)	..	1	2	..	8	3	2	..	1
10,000 " 20,000	3	1	1, (1)	..	..	2	..	6	1	..	..	..
20,000 " 30,000	2	..	..	..	..	..	..	1	1	..	..	..
30,000 " 40,000	..	..	2	..	..	..	..	2	..	..	..	..
40,000 " 50,000	..	..	..	..	..	..	..	..	..	..	..	..
More than 50,000	..	..	3	2	1	..	..	4	1	..	..	1

Grand Summary for the United States.

Population.	No. of places. Total.	No. of places. Reporting.	Day labor. Hand.	Day labor. Machine.	Day labor. Both.	Both day labor and contract.	Contract. Hand.	Contract. Machine.	Contract. Both.*	Disposal. Filling.	Disposal. Fertilizer.	Disposal. Filling and fertilizer.	Disposal. Carted away.	Disposal. D'mped in water.
3,000 to 4,000	384	311	248	9	22,(8)	4	16	3	(1)	146	9	8	18	6
4,000 " 5,000	236	205	162	2	23,(5)	1	6	4	2	94	12	10	11	4
5,000 " 10,000	465	435	290	11	76,(8)	9	13	10	7, (2)	225	33	21	15	3
10,000 " 20,000	226	215	113	10	74,(2)	4	5	6	1	133	17	15	3	6
20,000 " 30,000	78	76	40	6	29	..	..	1	..	52	6	7	2	1
30,000 " 40,000	43	41	13	3	25	..	..	..	..	32	5	2	..	..
40,000 " 50,000	14	14	5	1	8	..	..	..	..	10	1	1	..	..
More than 50,000	78	77	7	10	43,(1)	7	2	2	5	49	5	6	3	4
Total	1,524	1,374	887	52	300,(24)	25	42	26	15,(3)	741	88	70	52	24
Per cent of those reporting	111.0	100.0	64.6	3.8	21.8(1.7)	1.8	3.1	1.9	1.1(0.2)	76.0	9.0	7.2	5.3	2.5

*Numbers in parentheses indicate the report "Day Labor" only, or "Contract" only.

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ADVERTISING RATES: 20 cents a line. "Want" and "For Sale" notices, special rates, see page XXIV-XXIX. New copy for standing advertisements should be received one week in advance of publication; new advertisements, Monday morning. The pages containing "Want," "For Sale" and "Proposal" advertisements are held open until Wednesday noon.

A long chapter of municipal corruption at St. Louis is reaching a dramatic close with the arrest, conviction and sentence of the principal conspirators. Our readers are doubtless familiar from the daily press with the remarkable story of how a large proportion of the city council membership was recently found to have conspired together to sell their votes in favor of a municipal lighting contract.

The exposure of this corrupt conspiracy and the effective prosecution of those concerned in it is due to one faithful, fearless and competent public official, Circuit Attorney Folk. His efforts to enforce the law against robbery of the public treasury have now been successful in securing the conviction for attempted bribery of a political boss, who has long been credited with complete control over municipal politics and the award of municipal contracts, and whose power has been felt in State and even National affairs. On Friday, Nov. 14, Col. Edw. Butler, the "blacksmith boss" of St. Louis, was convicted of offering $2,500 to a member of the City Board of Health for his vote in favor of a garbage contract in which Butler was interested. Mr. Butler is also under indictment for the payment of $47,500 to 19 members of the city council of St. Louis to secure their votes for a public lighting bill. The conviction in the garbage case will be great encouragement and aid to the workers for honest municipal government everywhere.

It is, unfortunately, extremely rare to secure actual indictment, conviction and sentence of those guilty of the crime of bribing public officials; and when the briber is an influential politician and a man of wealth and prominence in public life, the forces which unite to defeat execution of the law are almost invincible. All the more noteworthy and all the more valuable as a warning to offenders against the public welfare is it, when such a man as Butler is brought to the bar of justice and made to pay the penalty. Indeed, the conviction of Butler deserves to rank with that of Jake Sharp as a victory for honest government.

We are well aware that some of our readers may say that Sharp and Butler were no worse than many others who get off scot-free, and that it is unfair to single out these men for exemplary justice. Those who argue in this way are but superficial observers. The danger that threatens Society to-day is the law-breaking spirit—the spirit of anarchy, of mob rule, of violence—the spirit that wields the boycott, that strikes down the non-union laborer as a scab, that forbids the union worker to do his duty as a citizen in the militia in defence of the public peace and law and order.

The seeds for this hatred of law are sown by men like Sharp and Butler and those who do their bidding. If the wealthy and influential may rob the public treasury, in defiance of law, why may not those at the other end of the social scale do the same?

It is because of these things that the heroic work of Circuit Attorney Folk at St. Louis, and the phenomenal house-cleaning which has taken place there, becomes of national importance. Ten thousand men will take warning by Butler's punishment, and be at least a little less ready to engage in schemes to defraud the public. Millions of others will witness the fearless execution of the law and will be a little less inclined to the belief that there is a law for the poor and friendless, but no law for the wealthy and influential.

The experience at St. Louis illustrates anew the fact that private ownership and operation of municipal services is quite as likely to lead to corruption as is municipal ownership. It also shows that mere forms of municipal administration are no safeguard against misrule, extravagance or corruption; and that the final responsibility for good government always rests with the voters who put good men or bad into office.

A large part of the present scandals at St. Louis are directly connected with efforts of private corporations to retain profitable municipal contracts.

It is generally believed that contract letting in St. Louis has long been manipulated in the interests of favored parties, and that by delays in advertising bids, competition has repeatedly been rendered impossible. All this has resulted in spite of a system of controlling public works and services, through a well-conceived Board of Public Improvements, which has been much approved by students of municipal government. No matter how able and disinterested the board in question might be, the legislative branch of the city government, at the dictation or in the paid interests of politicians and private corporations, has for years past been able to thwart all plans which put public before private interests.

That the remedy for such abuses finally rests with the voters is well shown when good men, like Circuit Attorney Folk, with public sentiment behind them, are placed in office. Finally, we wish to emphasize anew the folly of a city contract system which compels or permits a contractor to invest large sums of money in a garbage disposal or electric lighting plant under a short-term contract with a city, and leaves him to depend upon luck, favoritism, party politics or out-and-out bribery to secure a renewal of the contract, with the alternative of losing a large part of his investment if the contract goes to other parties. Such a system tends to make bribers of men who might ordinarily be honest. Its adoption is contrary to every principle of sound public policy.

One of the controlling factors which brought about the formation of the United States Steel Corporation, according to published statements made at the time, was the project of the Carnegie company to build a huge plant for the manufacture of pipe and tubes on the shore of Lake Erie. To prevent the war of competition which this would cause, and the catastrophes which important financial interests would experience, a great financier applied the "community of interest" plan and the Steel Corporation was the result.

There has been a disposition in some quarters to make out this financier as a public benefactor because he averted the threatened demoralization of the iron trade by the projected Carnegie pipe. The curious outcome of the matter is that, notwithstanding these good intentions, a huge increase in productive capacity has taken place in the pipe trade since the formation of the Steel Corporation. In other words, so far as the purpose in forming the trust was to prevent the building of unnecessary mills and factories and relieve the iron trade from the evils of overproduction, it has been a complete failure. Instead of checking the building of new iron and steel plants, the formation of the trust appears to have given an unprecedented stimulus to their construction.

The question whether coal should or should not be weighed when delivered onto locomotive tenders at coaling stations was discussed at some length at the recent Minneapolis convention of the Association of Railway Superintendents of Bridges and Buildings.

The practice of weighing each load of coal delivered to each engine at each coaling station, and keeping fuel accounts with the individual engines, is now almost universal. The general assumption is that by this method an accurate record can be kept of the coal used by each engine and a check thus kept on the men. As the records are usually posted on bulletin boards at roundhouses, etc., the men will naturally endeavor to make and keep good records, partly on the score of pride and reputation, but partly also to avoid the sarcastic remarks which the men at the bottom of the list receive from their fellows.

The opponents of this system, however, claim that by the ordinary methods of measuring, either by weight or by volume, the quantities are largely a matter of guess, and are so far from accuracy or uniformity that comparisons between them are practically valueless. It is, of course, possible to install accurate weighing machinery, and this is done at some large coaling stations at terminals, but such apparatus is far too expensive in first cost and maintenance to be installed at all intermediate coaling stations; and unless such plants were used universally, the coal records would be little more accurate or comparable than at present. Where the coal is measured by lines or marks on the bins (representing quantities of arbitrarily assumed weight), the weights arrived at are very variable, since the weight of a given volume of coal varies largely with the size and character of the different grades of coal used. Besides this, the coal records or accounts do not, as a rule, take into consideration the quantity already on the tender when a fresh supply is taken at the coaling station.

With such indeterminate factors as the weight and the quantity of coal consumed, comparisons between engine records may have really little meaning. The cost of operating this system is also considerable, involving the making up of the engine performance records and coal accounts in the division master mechanic's office and again in the auditor's office.

The general opinion of those who oppose the weighing and record system is that the money now spent in weighing coal and working out the coal consumption of the engines is practically wasted, and that a much smaller sum might be spent to better advantage in the employment of a larger force of traveling enginemen to instruct the engine crews in the economical use of fuel. The plan proposed is that the coal should be accurately weighed when shipped to the various intermediate coaling stations, and then charged out to the engines on the division at a certain average quantity per mile run. Thus the amount of coal charged to the division for a certain fixed period would be divided by the engine mileage of that division for the same period; the mileage of road engines would be known and that of the switch engines assumed in the usual way. It is believed that under this system the engine per-

formance would be equally as economical, the records equally as accurate, and the cost of obtaining the records of fuel consumption very much less than under the present system.

The account of a warehouse floor failure which appears on another page of this issue is of interest in several ways. It is primarily a lesson, as all failures of engineering works are, and none the less valuable a lesson because it is merely a repetition of old teachings, and a reminder against forgetfulness. Old and simple lessons require to be most often repeated: The teachings they convey are elementary and obvious, and pass into the mind without effort; but for that very reason they pass out of mind just as easily. Many past failures of engineering structures have told of neglected details, of little things taken on trust, without the analysis to which other elements of a construction are subjected. The present case renews this warning, and gives it additional emphasis.

An architect planned a warehouse building for heavy loading. He designed the walls, the posts, and the beams and joists in accordance with the methods and rules that have been found correct for such work. But in connecting these elements together he carelessly employed a detail very much weaker than the beams themselves; in fact, as brought out in our account, the joist hanger was probably not more than one-fifth as strong as the joists which it supported. As a natural consequence, the weak detail failed, and caused the collapse of the entire floor structure. The whole occurrence is an exact repetition of previous failures of structures: a detail was designed weaker than the main member which it served, and because the detail was small and hidden from notice, its weakness and its gradual failure did not become apparent until the final catastrophe occurred.

Two other matters should be here mentioned in connection with the Minneapolis failure. One of them concerns the architect's part in the affair. We have seen that he committed an error—and errors endangering the safety of human life are always culpable errors—in not giving proper attention to the design of an essential detail of his structure. Whether this came about through carelessness, or whether it resulted from a penny-wise scrimping in the details in an attempt to cheapen the structure, we cannot say. But the architect was at fault in another matter, and here his responsibility seems clear: Two days before the final fall, signs of weakness were noticed in the floor, and the architect was called in to advise. He declared that the building was safe, in spite of the sagging of the beams. The event, however, proved him wrong, and that his misjudgment did not involve more serious results than property damage does not decrease his fault.

Mere ignorance and poor judgment may be judged with leniency; but when the ignorant and incompetent man is confronted with evidence of defects in his work and still pretends to a knowledge which he does not possess instead of seeking advice from those competent to give it, it is a breach of professional and business ethics for which no excuse can be accepted.

One other matter that deserves mention is suggested by the following passage from a newspaper report on the collapse:

> The foreman who was in charge of the construction work stated that the steel stirrups had always previously been considered a safe support. They were guaranteed to hold an immense weight, and he stated that he could not account for the accident except by overloading of the floors.

Here we find the "practical sense" at fault. The stress conditions in the hanger are not simple, and it is but natural that the "practical man," unfamiliar with stress analysis, should go astray in his judgment. In another newspaper report the same man is quoted as saying in favor of the hanger, that it was "guaranteed to stand a strain of 60,000 lbs. to the square inch." A very satisfactory guarantee! Without enlarging on the point, we would merely suggest that the "practical" intuition has definite and close limits as a safe guide in construction, and that it is always in order to question it when stress calculations based on reasonable assumptions lead to a different result.

THE REPLY OF THE ANTHRACITE MINE OPERATORS.

In our last issue we gave the demands of President John Mitchell in behalf of the United Mine Workers of America, and briefly discussed the same. President George F. Baer, of the "Philadelphia & Reading Coal & Iron Co.," has filed with the Anthracite Strike Commission the reply of his company to those demands.

In brief the reply is as follows:

The first demand for 20% increase upon the price paid during the year 1901 to employees performing contract or piece work, is arbitrary, unreasonable and unjust.

This company denies that the present rate of wages is lower than is paid in other occupations in the same locality and controlled by like conditions.

This company denies that there is any such similarity between the mining of bituminous and of anthracite coal as to make wages paid in one a standard for the other.

This company is not informed as to the average annual earnings in the bituminous coal fields, but it avers that nearly all of its former employees, who during the past five months worked in the bituminous mines have returned to the anthracite region, preferring to work in the anthracite mines. And it further avers that the annual earnings of the anthracite mine workers is largely reduced by their refusal to work as many days as it is customary to work in other occupations, and that by reason thereof this company is subjected to great loss, and the cost of producing coal is largely increased, and the annual earnings of its employees diminished.

This company denies that the average annual earnings of the men working full time in the anthracite coal field are less than the average annual earnings for occupations requiring equal skill and training.

No boys are employed in and about the mines and breakers in violation of the statutes fixing the ages of employment.

In addition to provisions for education, ample hospitals for the care of the sick and injured are maintained in the anthracite coal regions.

This company avers that there is not anywhere else in the world a mining region where the workmen have so many comforts, facilities for education, general advantages, and such profitable employment.

This company denies that the second demand for a reduction of 20% in hours of labor without any reduction of earnings for all employees by the hour, day, or week, is either just or equitable, and avers that the reasons assigned in support of the demand are impracticable, in so far as they relate to the mining of anthracite coal. The certified miners, under present conditions, seldom work eight hours a day. The greater cost of production and preparation of anthracite coal for market is not the cutting of the coal. Many employees are paid by the month, the pumping continues day and night, the machinery is expensive, and the cost of coal is largely conditioned on the collieries running full time. The output is entirely dependent on the quantity of coal a certified miner is willing to cut daily, and because of this it is seldom practicable to work the full breaker time.

In general, we deny in so far as they relate to anthracite mining, that the 10-hour day is detrimental to the health, life, safety, and well-being of the mine workers, that "shorter hours improve the physical, mental and moral conditions of the workers," that "shorter hours increase the intensity and efficiency of labor."

It admits that the tendency of national and state governments and of labor organizations is toward shorter hours, but denies that a working day of less than 10 hours will be of real advantage to the workmen engaged in and about the anthracite mines and collieries. In some exceptionally exhausting work a day of 10 hours is too long, but there is no exhausting labor which justifies a reduction of hours of work in the anthracite coal operations.

Any increase in wages will necessarily increase the price of coal to the public, restrict its use, and seriously affect the ability of the industries using it as fuel to compete with the industries using bituminous coal; it will bear heavily on the workmen, and necessarily oppress the general public, and injure the general business of the country.

This company, replying to the third demand, says: That it has had no disagreement with any of its employees about the weighing of coal. The quantity is usually determined by measurement; that when coal is mined by the ton, it is customary and necessary to make allowances for slate and impurities. But this company does not mine by the ton. It denies that there is anything unreasonable or unfair in the method it has practiced in arriving at the measurement of the coal from its mines.

At the Shamokin convention of the United Mine Workers of America, referred to in the statement, it was resolved: That the United Mine Workers at any colliery, when the employees refused to become members of the organization and wear the button, the local governing such colliery, after using all persuasive measures to get such employees to join, and failing in such, shall have full power to suspend operations at such collieries until such employees become members of the organization.

Subsequently, to wit, on May 12 the United Mine Workers of America inaugurated a strike, and by threats and intimidation caused a suspension of work at all mines. Under date of May 21 they issued a formal official order requiring all pumpmen, firemen, and engineers to desert their posts of duty, with intent to force submission to their unjust demands by the destruction of the mines. By threats and violence they tried to prevent other men from taking the places of the firemen, pumpmen, and engineers. The said United Mine Workers of America well knew that if this company did not succeed in keeping the pumps going the mines would be so greatly injured that it would be impossible to mine coal for many months after the strike ended, and that by reason thereof the workmen of the anthracite fields would be deprived of employment and the public be made to suffer untold hardships because of inability to procure fuel during the winter months.

This company, further answering, avers that the jurisdiction of this commission is limited to the conditions named in the statement of the coal company presidents, by virtue of which the commission was appointed, and that by express terms, as well as by necessary implication, the investigation is confined to matters affecting its employees and excludes the United Mine Workers of America from any part or recognition in the proceedings, recommendations or decisions of this commission.

Further answering, it says that if and when a labor organization, limited to workers in anthracite mines is created which shall obey the laws of the land, respect the right of every man to work whether he belongs to a union or not, and shall honestly co-operate with the employers in securing good work, efficiency, fair production, and necessary discipline, trade agreements may become practicable.

Upon the whole the answer of President Baer is a very fair presentation of the reasons for refusing the demands of the miners. We note, however, that President Baer is careful to say "working full time" when speaking of annual wages, but, as we have shown, "full time" is exactly what the miners have not been getting.

Bearing upon this very point is a table published in "Mineral Resources of the United States" for 1901, from which we abstract the following:

	1898		1899		1900		1901	
State	Aver. No. days worked.	No. mine workers.	Aver. No. days worked.	No. mine workers.	Aver. No. days worked.	No. mine workers.	Aver. No. days worked.	No. mine workers.
Ala.	250	10,733	258	13,481	257	13,967	236	17,370
Cal.	265	284	287	369	309	378	289	428
Colo.	220	6,440	246	7,166	264	7,459	253	8,870
Ill.	175	35,026	228	36,756	226	39,101	220	41,880
Md.	253	4,818	275	4,624	203	5,319	262	5,333
Mich.	245	715	232	1,291	261	1,704	247	2,276
*Pa.	229	79,611	245	82,812	242	92,692	230	101,904
Wash.	270	3,145	259	3,330	289	3,670	276	4,545
†Total.	211	255,717	234	271,027	234	304,375	225	340,235

*Bituminous. †Of all U. S.

From this table we see that the bituminous miners of the United States averaged 211 days worked in 1898, 234 in 1899, 234 in 1900 and 225 in 1901. As compared with this, the anthracite miners averaged 152 days worked in 1898, 173 in 1899, 166 in 1900 (short strike), and 196 in 1901, and the average for the past 25 years has been 189 days actually worked.

But even the bituminous miners have averaged fewer days worked per annum than they readily could work. Note, for example, in the table above that in 1900, bituminous miners in Colorado worked 264 days, in Washington 289, and in California 309.

Society at large eventually pays for all the wastage of labor going on in the anthracite districts, where the men have averaged less than 6½ hours worked per working day for the last quarter century. Hence it cannot be said with truth by the mine operators that it is nobody's business how they choose to operate their mines. Nor do we find President Baer now maintaining any such attitude. He concedes the fact that the miners have not worked "full time," but puts the blame on their shoulders.

Unless the coal miners in Pennsylvania materially differ from miners elsewhere, we cannot agree with President Baer that the fault is theirs in not working full time. It may be replied that a great number (about 30%) of "Sclavs" and other foreigners work in the Pennsylvania mines.

This might be an argument of some force were it proved that these "Sclavs" are lazier than other men, but, on the contrary, they are notoriously "penurious" according to some, "thrifty" according to others. They are eager for work, or for the money that the work will bring. Moreover, long

before these "Sclavs" were imported the very same conditions existed, and never in the history of anthracite coal mining have the men averaged much more than 200 days worked per annum. As shown in our last issue, there has always been an excess of workers, primarily because coal has been mined in a "hand to mouth" fashion, necessitating a large force of men to supply the market during the season of greatest demand. As a result of this system, a high rate of daily wages had to be paid, and this high rate of wages has attracted men, in a less degree, just as did the tales of gold discoveries in the Klondike. Men rush in without counting the chances of idleness during a great part of the year. To remedy both these conditions we have advocated paying all "day laborers" by the week or month instead of by the day, with no time docked for shutdowns of plant. President Baer says that many of the workers are now paid by the month. He does not state that they are bosses, clerks, pump and enginemen and the like, who form a very small per cent. of the whole number.

We agree with President Baer in his claim that there is nothing intrinsically wrong in the present method of paying for coal by the car instead of by the "legal ton," where contract work is done. Miners, however, consider it unfair, and we can see no reason why the operators should resist their demand in so far as the way of measurement is concerned. The rate to be paid per ton is, of course, an entirely different matter, and should vary with the conditions of mining. Any inflexible schedule of rates would be wrong, being too low in some cases, too high in others.

Finally, as to President Baer's criticism of the act of the Miners' Union in calling out the engine and pumpmen, no fair minded, impartial man will deny that it was indefensible—an act, that had it succeeded, would have caused incalculable loss and ruin not only to the mine owners, but to the public. When such acts were followed with destruction of lives and property by the members of the union, we can not wonder at the bitterness with which the operators have opposed any recognition of the United Mine Workers of America.

President Baer closes his reply with an expression of willingness to deal with any labor union confined to workers in the anthracite districts, provided such union will respect the laws of the land, and the right of every man to work unmolested.

This is a position not hitherto taken by the coal operators, and one that cannot but meet with public approval.

LETTERS TO THE EDITOR.

Concrete-Steel Railway Ties on an Italian Railway.

Sir: I have been given to understand that the German railroad officials have been very carefully watching the experiments that have been made in Italy on the Adriatic railroad line with the iron-concrete sleepers and the practical as well as chemical tests to which they have been subjected.

The new sleepers are described as being 8.53 ft. long, and in section resemble a triangle with the corners cut off. The apex of the triangle is at the top, but at the rail seats the sleeper is widened out at the top to its full bottom width of 7.87 ins. These sleepers weigh about 287 lbs., of which the iron reinforcing bars weigh about 88 lbs. Their cost is about $2.20 each, which is about double the cost of the wooden sleepers hitherto used; but it is hoped that their life will be 30 or 40 years. A few of these sleepers have been under the rails at Ancona since 1900, and, so far, they have given every satisfaction. Yours very respectfully,

Oliver J. D. Hughes, U. S. Consul General.

Coburg, Germany, Oct. 28, 1902.

More About Scow Measurement.

Sir: Referring to the matter of scow measurement, letters regarding which have appeared in your issues of Oct. 23, Nov. 6 and 13, 1902, the following information relative to the scows used by Hughes Bros. & Bangs, contractors for the Buffalo, N. Y., breakwater, now being built under the direction of Major T. W. Symons, Corps of Engineers, U. S. A., may be of interest.

All the scows used by these contractors are fitted with glass gages, one at each end in the center line of the scow. These gages consist essentially of a stand-pipe 3 ins. in diameter, into which are inserted two brass cocks, one at the bottom, the other at the top, the cocks being placed from 4 to 7 ft. apart. Glass tubes are fitted between the cocks. Close to the glass tube a graduated wooden rule is attached, this rule being graduated to feet, tenths and hundredths; and so placed that, at all times, it gives the actual draft of the scow, the bottom of the scow being assumed as zero. The scows were very carefully measured with a steel tape line (many while yet in the building ways) and the cubical contents (outside) calculated; from which data suitable tables were prepared. To determine the load, the average light reading is taken, and its value looked up in the tables; the same is done with the loaded readings, the difference is the load in tons.

All scows are also tested with an actual test load, carefully weighed on track scales. A few of these tests may prove interesting.

The scow "H. B. & B. No. 8" is 130 ft. long, 32 ft. wide, and 9.5 ft. deep. It was tested with an actual load of 612.5 tons, the tables gave 613.2, a difference of only 0.7 tons. At another time this scow was tested with an actual load of 648.6 tons, the tables gave 648.0, a difference of 0.6 ton. Other scows gave nearly as close results. Respectfully,

Emile Low, M. Am. Soc. C. E.

Buffalo, N. Y., Nov. 14, 1902.

Lining Water-Power Canals with Plank at Sault Ste. Marie, and at Lowell, Mass.

Sir: Your issue of Sept. 25 gives an interesting account of the power plant at the "Soo" and the lining of the canal sides with plank. This is not so new an idea as the account would indicate. Mr. Hiram F. Mills has been lining the canals at Lowell for the past four or five years, the intention being to reduce the friction head. What the results are I do not know, and it might be of interest to the readers of the News if you could get some information from Mr. Mills. Respectfully yours,

James H. Harlow.

Pittsburg, Pa., Nov. 3, 1902.

(In accordance with the above suggestion, we wrote to Mr. Mills, with the result given below. —Ed.)

Sir: Your letter of Nov. 13 is received. My lining of the bottom and slopes of some of the Lowell canals in 1893 and 1894 with plank caused great saving in the loss of head, but as it was done in connection with deepening and other changes, it is not practicable to say just how much was due to each cause. For example: One of the canals, 3,500 ft. long, receiving water from mills on either side in the upper quarter of its length, and discharging at several points in the lower two-thirds of its length, had originally a loss of head in its length, when carrying in its middle portion 3,709 cu. ft. per sec., of 4.02 ft. By deepening in the middle and putting in a smooth plank floor on the bottom and on the slopes a part of the way, and guiding the entering water, the fall in its length with the same quantity flowing and same height at upper end is 1.32 ft.

Another canal, where water entering and flowing 900 ft. had a loss of head of 1 ft., was deepened and smoothed with cement and with plank floors on bottom and slopes until the loss of head was reduced to 0.25 ft.

Irregularities of form, or method of entering, or draft from the canals, prevent satisfactory determination of "C" for use elsewhere in either case. Respectfully yours,

Hiram F. Mills,

Engineer Proprietors of the Locks and Canals on Merrimack River.

Lowell, Mass., Nov. 15, 1902.

The First African Transcontinental Railway.

Sir: It may be of general interest to your readers to know that the first transcontinental railway line in Africa has just been completed. The junction was made on Oct. 6, 1902, at a point about 626 miles west of Beira, and about 1,423 miles from Cape Town.

On Oct. 5, the plate-laying gangs from Bulawayo and Salisbury, respectively, stopped work within 20 chains of each other, and on the arrival of the contractors and engineers from each end the next day, the gangs began to link in the gap at 1.30 p. m. At 1.45 p. m. the closures were being cut. At 1.54 they were bolted in, and at 1.56 the two engines were run together, breaking a bottle of champagne which was tied to the draw-head of the engine from Salisbury. This makes a continuous rail connection between Cape Town and Beira, and in addition to opening up Rhodesia, it cannot fail to have an important bearing on all Central and South African freights.

The contractors for the work were Messrs. Pauling & Co., of Victoria St., Westminster. The engineer in chief was Sir Charles Metcalfe, Bart., with Sir Douglas Fox as consulting engineer. Among those present at the opening were Mr. Harold Pauling, Mr. S. F. Townsend, chief resident engineer, Bulawayo, and Mrs. Townsend; Mr. W. Tower, resident engineer; Mr. Chas. Corner, district engineer; Mr. Ormsby, and Mr. Carter, contractors' agents of Salisbury and Bulawayo, respectively, and Mr. H. J. Bromley, their district engineer.

The gage is 3 ft. 6 ins., being the same as that of Cape Colony. The rolling stock is comparatively heavy for the line, consisting of 12-wheel locomotives, eight wheels coupled, with a four-wheel truck. The locomotives have outside cylinders and weigh over 80 tons. The freight cars have a capacity of 40,000 to 50,000 lbs.

Between Beira and Salisbury the line was built on a maximum gradient of 1 in 50, with curves of a minimum radius of 5 chains. Between Salisbury and Bulawayo, however, the maximum is 1 in 80, with a minimum radius of 8 chains, giving a net paying train load of about 400 tons. The rails are of 60-lb. section, with steel sleepers of the usual turtle-back pattern with lugs and keys, weighing about 70 lbs. each and spaced 2 ft. 9 ins. c. to c.

The linking in of the last 20 chains was a very smart piece of work. Mr. Loggie, contractor for the plate-laying on the Salisbury end, having over 300 Kaffirs, and Mr. McCarthy, contractor on the Bulawayo end, a similar number. These "boys," as they are called here, became greatly excited as the engines hove in sight and the signal was given to start closing in. With about 22 Kaffirs to each rail, they danced along with the material singing and shouting and making the most extraordinary gesticulations. As the two gangs neared each other they yelled and shook their bars at one another in a way that was a good imitation of the imps of Lobengula on the war-path.

I am, yours faithfully,

C. Corner, Assoc. M. Inst. C. E.

Rhodesia Railways, Ghelo, Matabeleland, Oct. 12, 1902.

(We show herewith a sketch map which will give the reader a general idea of the territory

Sketch Map of South Africa, Showing Railway from Beira to Cape Town.

covered by this new transcontinental line. The connecting link just completed from Bulawayo to Salisbury has not been put in, as no maps are yet available showing its route.—Ed.)

Typhoid Fever and the Soil.

Sir: In the Supplement to Engineering News for Oct. 23, in a note on my paper on "Typhoid Fever from Sources Other Than Water Supply," it is intimated that I have probably "overestimated the dangers of infection from the soil, without the agency of water." Since that paper was written facts have come to my knowledge which indicate that instead of overestimating, I have probably underestimated the danger, and that typhoid bacilli may live in particular soils much longer than a year, which is the limit noted as possible in the paper in question. The important point is that their growth resembles that of the fungi in general in requiring very special conditions. A mushroom, for example, will refuse to grow unless there is rotting wood, not from trees in general, but from some particular species of tree, or in like manner unless there is fecal matter, not from animals in general, but from some particular species of animal, and typhoid bacilli behave in much the same way. Indeed, it is characteristic of bacilli generally to require the presence of organic matter of some one variety in order that they may grow luxuriantly. The persistence of typhoid fever in some very limited area where, as not infrequently happens, the water used is above suspicion, points unmistakably to soil contamination. Indeed, there are cases in which no other explanation appears possible. If proper laboratory methods are applied in cases such as these it is very likely that recovery of the typhoid bacillus from such soils will become possible for periods as long as a year, instead of being exceptional for such extended periods as is the case at present. In any event, the evidence already at hand justifies avoidance of soil contamination by most thorough measures of disinfection in the sick room. Sulphate of copper solution of the strength of one pound (costing ten cents) to 2½ gallons of water is effectual, and its general use would diminish typhoid greatly if not eradicate it entirely.

Yours very truly, M. A. Veeder, M. D.

Lyons, N. Y., Oct. 29, 1902.

(The investigations of this subject carried on for a number of years past by specialists employed by the Local Government Board of Great

Britain, and the discussions in the recent book by Dr. Geo. Vivian Poore, on "The Earth in Relation to the Preservation and Destruction of Contagia," confirm us in the belief that Dr. Veeder overestimates the danger of typhoid "infection from the soil, without the agency of water." The experiments conducted or cited by the authorities already mentioned seem to show that as a rule the typhoid bacillus dies speedily after admission to the soil; but whether it does or does not the germ is unlikely to get from the soil to human beings without the agency of water. Nevertheless, as we said in our issue of Oct. 23, it is desirable that typhoid fever excreta should be properly disinfected and other measures taken to prevent the spread of the germs by flies. Dr. Poore, it may be added, maintains in his book, mentioned above, that it is far safer to bury typhoid excreta slightly beneath the surface of well-tilled soil than to rely on disinfection. But in crowded cities well-tilled soil is rarely available, and even in the country burial is difficult or impracticable when the ground is deeply frozen, and the work at any time is likely to be carelessly done. Unless, therefore, it can be proven that disinfectants do not disinfect there is much to be said in their favor in all cases, while in thousands of instances earth burial is entirely out of the question.—Ed.)

The Character and Composition of the Cable Covering for the New East River Bridge.

Sir: The account by Mr. Hildenbrand of the coating for the cables of the New East River Bridge, published in Engineering News of Nov. 13, naturally arouses interest in the character of the material used for the permanent protection of so important a structure. I will, therefore, give a brief explanation of the grounds on which I recommended it and on which it was adopted by the engineers in charge.

Cotton cloth, if reasonably protected from the weather and not subject to abrasion, is partially indestructible, as shown by the wrappings of Egyptian mummies, etc.; it, therefore, is a suitable foundation, especially as it is both flexible and elastic. The compound with which it was both saturated and coated has for its most important constituent oxidized linseed oil. This substance has been known for hundreds of years and has been studied by chemists ever since there was a science of chemistry; it is a substance obtained by oxidizing oil either in films, or by blowing air through it; it is elastic, somewhat like rubber, but much less elastic, infusible, absolutely insoluble so far as we know in water, alcohol, turpentine, benzine, or in animal, vegetable or mineral oils. It also resists dilute acids. Large quantities of it have been exposed to the air, both in and out of doors, for years without change. The obstacle which has prevented its use for many purposes has been the difficulty of getting it into a liquid form, as it is both infusible and insoluble, and my attention, and that of my associates, has for many years been given in considerable part to this problem.

As it presented itself to me, the most likely solution seemed to be in the line of adding to the oil before or during oxidation, a suitable flux, which should not only make a fusible compound, but one which would have as great permanence as the oil itself. It is well known that an ordinary oil film, such as a paint film, is somewhat porous; this is in part because before becoming thoroughly oxidized it is in a gelatinous state, and in further drying it contracts and this causes it to be porous. One of the chief reasons why a varnish film is so very much less permeable than an oil film is that the resin which is dissolved in the oil acts as a flux and keeps the film in the condition of a viscous liquid until oxidation is complete. If, therefore, such a flux can be combined with the oil it may be oxidized until it becomes normally a solid; but being under the influence of heat, it is a liquid until the heat is removed.

This result I reached some ten years ago, and solid fusible samples of this very cement which was used on the cables were shown seven or eight years ago to several persons, one of whom I remember was the present chief constructor of the navy department, Rear-Admiral Bowles. The desirability of such a compound for certain marine purposes had been some years before pointed out to me by Capt. N. G. Herreshoff. The most difficult thing in this case is to get a flux which will itself be in its nature as imperishable as possible and will be efficient when used in so small quantity as not to seriously affect the physical and chemical qualities of the oil. I am free to say that the problem has proved difficult, and the preparation of the compound requires a high degree of skill, but the results have been satisfactory.

The material is free from any coal-tar or resin compounds and also, which is remarkable, absolutely without any "driers," such as lead or manganese; as may easily be shown by chemical analysis. It has been subjected to practical tests for many years, among which I may say that I used it to patch a hole by the side of a chimney on a 45° roof, and it not only retains its rubber-like elasticity, but does not run off, a rather remarkable case. It has also been dissolved in turpentine and a large amount of it used as a varnish, where it is exposed to the air in a film not over two or three-thousandths of an inch thick; it has stood in this form for several years, both in air and under water. I have no doubt as to its durability. The cotton duck was saturated with it, and when wound on it was immediately heated; though not heated enough to fully melt it, it reached a point where it would weld, like tortoise-shell, and the result is that the cables are covered with an absolutely impermeable, tough, elastic and permanent coating. The whole problem was one of great interest as well as practical importance.

A. H. Sabin.

45 Broadway, New York, Nov. 14, 1902.

Notes and Queries.

C. C. L., Schenectady, N. Y., writes:

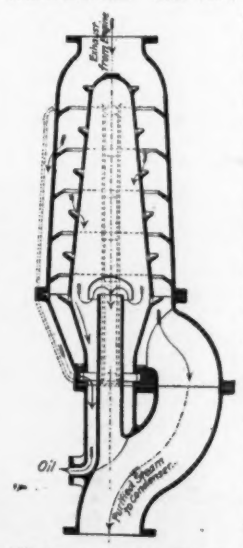
Could you direct me to any information touching upon the wear of concrete piers when subjected to a severe action of floating ice? I refer, of course, to a pier constructed entirely of concrete. If there is no available data on this subject, would you let this communication appear in your columns? By so doing, I presume the experience of others could be easily brought out.

It has long been customary to face concrete work exposed to abrasive action or shock with cut stone. In some recent structures, however, concrete has been exposed without such protection. Examples are the St. Croix dam (Eng. News, Jan.-June, 1901, p. 426) and the Tallassee dam (Eng. News, July-Dec., 1901, p. 418). We shall be pleased to hear from any of our readers who can report experience with concrete piers exposed to ice abrasion.

Our attention has been called to two errors in the Personal columns of our last issue. In noting the resignation of Prof. E. A. Fuertes as Director and Dean of the Faculty, College of Civil Engineering, Cornell University, we were in error in stating that Professor Fuertes was Chief Engineer of the Croton Aqueduct. He was from 1865 to 1869 in the employ of the Croton Aqueduct Board as Assistant Engineer. We are also informed that he has never been Consulting Engineer to the City of New York. In noting the death of Mr. Julius Munckwitz, Sr., we stated that he was the first Supervising Architect of Central Park, New York, but we are advised that his appointment to that position did not occur until 1870, 14 years after Central Park was begun. Our source of information in both these cases was the notices published in the New York daily papers.

A GERMAN OIL SEPARATOR FOR EXHAUST STEAM.

The illustration herewith represents a German design of oil separator for exhaust steam which may be of interest in comparison with American constructions. The view shown is a longitudinal section through the appliance, and indicates the course of the steam through the separator, and the manner of catching and draining off the oil. The separator is virtually an enlargement in the exhaust main, in which small projections adapted to retain the oil particles are presented to the current of steam; the steam maintains the same general direction and there are no abrupt angles in its line of flow. It is intended in this manner to make the loss of pressure in passing through the device a minimum. The oil-retaining projections form little troughs around the walls of an annular space, which the steam first enters. The oil separated is drained from these troughs in two directions, outward into a duct leading to the oil drain pipe, and inward, together with the steam, into the inner cylindrical body, where the oil trickles down the walls to the oil drain, while the purified steam passes down to the discharge pipe. The principal separation takes place in the annular steam space, where the steam is forced to follow a sinuous path between the projecting troughs, the particles of oil being thrown off into the troughs by centrifugal force. There is a very large surface of metal exposed to the current of steam, and probably this aids in separating the oil by its being retained on the rough cast-iron surface.



Oil Separator for Exhaust Steam.

The separator may be built to be placed alongside of the condenser, where the latter is on the same floor with the engine, or to be placed above the condenser; the latter style is shown in the cut, the engine being set on the main floor above, and the condenser in the basement below. The appliance is built by the Crimmitschau Machine Works, of Crimmitschau, Saxony.

ECONOMY DERIVED FROM REHEATING COMPRESSED AIR.

The results of tests made by W. G. Edmondson and E. L. Walker, students at Cornell University, are given in the "Engineering and Mining Journal," from which the following is abstracted: Compressed air at 60° F. was first passed through a meter, then into a reheater, consisting of a coil of three lengths of 1¼ in. wrought iron pipe, surrounded by an outer casing of 6 in. pipe. The casing was covered with asbestos. Gas was used as fuel for reheating and was also metered, thus making possible very accurate testing of the efficiency of the motor, which was a 2-HP. vertical engine with a shaft governor.

The engine was provided with a Prony brake and an indicator.

The series of tests were made with several one hour runs, gage pressure, varying from 57 to 82 lbs., and temperature of air raised by reheating from 90° to 320°, the results being carefully recorded and tabulated.

For general purposes we need only give the following summary of results: (1) The net gain in economy was greatest for the lower gage pressure of 57 lbs.; (2) The curve of efficiency indicates that there would be no further gain by heating the air above 450° F., and with the engine used 400° F. was the maximum temperature consistent with smooth running on account of the ill effects of a higher temperature upon packing and lubricant; (3) Reheating the air relieves the engine from difficulties due to freezing of the moisture in the exhaust passages, with resulting choking; (4) The economic advantages of reheating were conclusively proved. A compressor able to supply 100 HP. of cold air to the motor, could suppply 178 HP. by the use of reheaters.

The following is condensed from a much larger table. In these tests the gage pressure was 57 lbs.; the gas had a thermal value of 530 B. T. U. per cu. ft.; and the efficiency of the reheater was about 50%; length of each run was one hour.

Number of run	1.	2.	6.
Cu. ft. of air per hr.	377.0	323.4	238.0
Weight of air per hr., lbs.	143.5	110.4	87.8
Increased temperature of air	0	89.7°	326.7°
Resulting metered inc. in volume.	0	16.4%	61.1%
B. T. U. absorbed by air per hr.	2,659	2,350	6,820
Cu. ft. gas per hr. used in heating	0	8.7	28.0
B. T. U. supplied to heater per hr.	0	4,615	14,840
Gain in thermal economy	0	28.1%	38.4%
Percentage of power from heater.	0	31.2	44.6
Equiv. HP. from heater per hr.	0	0.196	0.304
D. HP.	0.629	0.693	0.682
I. HP.	0.909	0.976	0.890
Mechanical efficiency of engine	69.2	71.0	79.3
Total thermal cost per D. HP. hr.	415,000	298,670	255,800
Gain in thermal economy	0	28.1%	38.4%

A SUBMERGED FILTER BED AT PHOENIX CIYY, ALA.

A submerged filter bed and gallery was built at Phoenix City, Ala., early during the present year, as a part of a new water-works system. The bed and gallery are designed to clarify the water of Holland's Creek, which is described as a stream of considerable size. The bed is over and around the gallery, having a total area of 1,760 sq. ft., and a depth of 3 ft. over the gallery and of 9½ ft. around it. The inside dimensions of the gallery are 7 × 100 ft., × 6 ft. high, but it is not stated whether the width and length are for the bottom or top, between which there is a difference of 1 ft., due to a 6-in. batter on the inner face of the gallery walls. The bed and gallery are placed lengthwise of the creek, in an excavation 16 × 110 ft., × 9 ft. deep, with a bottom grade of 5% down stream. The excavation was through 3 ft. of sand, 2 ft. of soapstone, soft enough to be loosened and removed by plows and scrapers, and

4½ ft. of hard granite, which required blasting. The side walls, composed of the excavated granite, were built up dry, 6 ft. high, with a thickness of 2 ft. at the bottom, battered to 1½ ft. at the top. At a height of 5 ft., 2 × 6-in. plates, and, on these 2 × 12-in. joists, 12 ins. c. to c., were built into the walls. The roof is composed of 2 × 4-in. scantling, laid longitudinally, with ½-in. spaces between each piece. Surrounding the walls and on top of the roof is 4 ins. of gravel, and outside and above this is the sand bed, which has a depth of 3 ft. 8 ins. over the gallery and 9½ ft. outside the

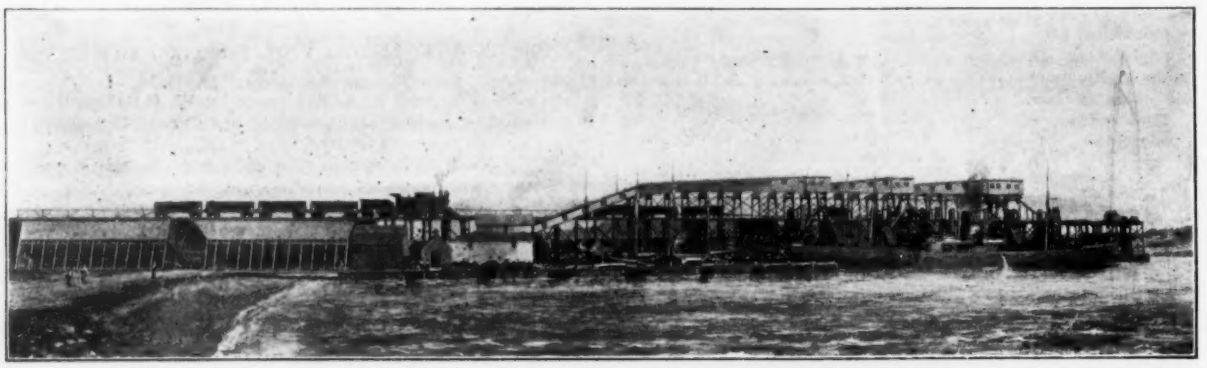


FIG. 1. COAL SHIPPING PIER OF DOMINION COAL CO. AT LOUISBURG, CAPE BRETON.

gravel surrounding the gallery walls. The water from the gallery is pumped to a reservoir by means of a Deane triplex pump, rated at 300 gallons per minute, or 432,000 gallons per day, and a Blakelee gasoline engine, rated at 16 HP. The pump is 19 ft. above the lower end of the suction, and the reservoir is 192 ft. above the pump. The water-works were designed by Mr. P. Byrne, Birmingham, Ala., and Mr. Conrad Ohme was resident engineer. The information given was taken from a description of the works in the form of a paper read before the Engineering Association of the South on Sept. 11, 1902. Mr. Ohme states that the works were accepted on July 18, 1902, and that the filter has furnished "a plentiful supply of clear water at all times, regardless of the condition of the creek." It should be remembered, however, that the works had been in operation but two months when the statement was made, and that the consumption must have been relatively small.

THE NEW SHIPPING PIER OF THE DOMINION COAL CO., AT LOUISBURG, CAPE BRETON.

The development of the Cape Breton coal fields by the Dominion Coal Co. is one of the most notable incidents of the last few years in the bituminous coal industry of North America. In our issue of Sept. 13, 1900, we gave a brief description of the company's mines and plant, and referred to the fact that at Louisburg, one of its two available seaports, plans were being carried out for a considerable enlargement of its shipping facilities between railway and steamer. These plans have been completed for some time now and the successful operation of the new shipping pier makes the time ripe for a more extended description of the work than was possible at our former writing.

The new coal shipping pier at Louisburg, Cape Breton, is actually a work of reconstruction and enlargement and not a new construction in its entirety. The old pier was a double-deck structure, onto the upper deck of which coal cars were run by gravity, dumped into chutes leading to vessels lying in the docks alongside, then dropped to the lower deck by a drop-table, and run by gravity to the shore tracks, where they were gathered up and returned to the mines for reloading. The improvement consisted, briefly, in building large storage pockets on shore from which the coal could be taken by belt conveyor along the pier at an elevation above the upper car deck and discharged at suitable intervals into chutes leading to the vessels. The new construction simply added to the capacity of the old pier, which retained all its original facilities for transshipping coal direct from the cars.

A general view of the reconstructed pier is given by Fig. 1, but a better understanding of its arrangement and operation are had from the drawings of Fig. 2. Referring to Fig. 2, the upper deck level of the old pier is indicated at A B, and the lower deck level at C D. At E and F are indicated the new pockets built underneath the upper deck. These pockets have an aggregate capacity of 10,000 tons of coal. They are of timber construction with hopper bottoms. Underneath the pockets for their entire length there is a tunnel occupied by a belt conveyor, which rises out of the tunnel at the water end of the pocket and continues upward and along the pier in a special structure elevated above the upper car deck. In operation coal from the pockets falls on the belt conveyor and is carried by it along the pier, where it is discharged into chutes leading to the vessels alongside, as is indicated by Fig. 2, where a b, c d and e f indicate the successive lengths of belt conveyor, G indicates the power house, and S S indicate the vessel chutes.

Details of the construction of the coal pockets are given for a typical bent by Fig. 3. Fig. 4 is a view of the inside of the tunnel showing the conveyor belt about half-loaded. A typical bent of the conveyor belt structure above the upper deck of the pier is shown by Fig. 5. The power house contains a 125-HP. engine, with boilers and accessories, which runs the first two sections a b and c d of the belt conveyor. This engine has a rope drive to a jack shaft with clutch pulleys from which the conveyors are driven. The power house also contains in duplicate a direct-connected electric generating set which furnishes current for lighting purposes and for driving the electric motor which operates the end section e f of the conveyor belt. This motor is belted to the conveyor with a gear and pinion for reducing speed. The conveyor belt used is 36 ins. wide and has a travel of about 700 ft., with a total rise of 70 ft. in which the steepest slope is 22°. The speed of the belt is 700 ft. per minute, and it can convey and discharge on either or both sides of the pier about 750 to 800 tons of coal per hour. Between 300 and 400 tons of coal per hour can be loaded direct from the cars.

The reconstructed dock as described was put in operation on Nov. 30, 1900, and has been in continuous operation ever since, both day and night operation being possible when required. The additions to the old dock, including the coal pockets, the conveyors, etc., were designed and built by the Robbins Conveying Belt Co., of New York city, to whom we are indebted for the information from which this article has been prepared.

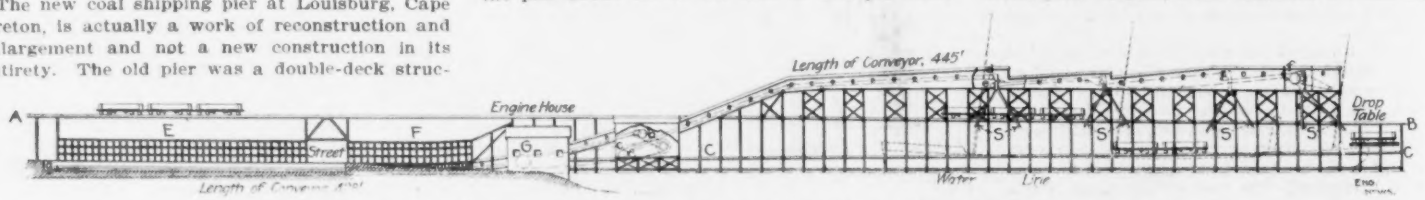


FIG. 2. SKETCH ELEVATION OF COAL SHIPPING PIER AND BELT CONVEYORS AT LOU'SBURG.

NOTES ON SHAFT SINKING AND ORE HOISTING.

Shaft sinking is treated by Mr. C. K. Colvin, M. E., Denver, Colo., in a short article in the Oct. 4 issue of the "Mining and Scientific Press."

A feature of evident merit, as described by Mr. Colvin, is the "float," which is a device to prevent destruction of shaft timbering by blasts at the bottom. The "float" consists of two thicknesses of 1-in. boards laid crosswise and faced on each side with ¼-in. boiler plate well bolted. The wood center acts as a cushion to protect the plates. The float is built at the bottom of the shaft and is made large enough to extend beyond the timbers at least 2 ins.; it is supported at the four corners with 2-ton chain blocks, and just before firing is pulled up tight against the bottom timbers, and the bucket hole through its center is closed with a chain net. When the shaft is ready for a new set of timbers the "float" is dropped down out of the way. After some months' use the "float" becomes battered into a cup shape and is then turned over so that it will be battered back again.

An instructive paper was read before the Canadian Mining Institute at Nelson, B. C., Sept. 12, 1902, by Mr. Alfred C. Garde, M. E., Genl. Mgr. Payne Mines, Sandon, B. C., and the subject of Skips vs. Cages discussed. A skip, it may be said, is really a very large bucket into which the ore is dumped at the respective levels of the mine, while a cage receives the loaded cars, which are hoisted therein to the surface and run off to the dumping tipple. Mr. Garde says: "Wherever it is possible to use a skip I always prefer it to the cage," and adds that within the last few years the skip has largely replaced the cage in the large mines of Butte, as well as in South Africa, both for vertical and inclined shafts. It is obvious that where skips are used the power otherwise consumed in hoisting the dead weight of cars is saved. In one instance the dead load of cage and cars was 2,400 lbs. for every ton of ore, while a 5-ton skip that was substituted weighed only 1,000 lbs. for each ton of ore.

To make the skip system a success it is necessary to have bins or ore pockets cut out at each level of the mine to receive the ore and waste during one shift. The pneumatic ore bin gate, first introduced at Butte, enables the operator to shut off the ore stream within a second at the instant the skip is loaded.

CONCLUSIONS BASED UPON TESTS OF DYNAMITE.

Testing dynamite with the "Abel block" is treated in a paper by Mr. A. W. Warwick, in "Mines and Minerals." The Abel block is a cylindrical piece of lead, 5 ins. diameter × 5 ins. high, with a ¾-in. hole, 2½ ins. deep, in which a charge of 5 grams of dynamite is placed in the form of a small tissue paper enclosed cartridge. The cartridge with its cap are pushed home and tamped with sand that has passed a 60-mesh screen. The block is placed between two 1 × 6 × 6-in. iron plates and the whole held together with two iron rings, 1½ × 1½ ins. section, and securely wedged.

The fuse is fired and the resulting cavity in the lead is measured by pouring in water, then by deducting the volume of the original ¾-in. bore hole the increased volume due to the explosive is ascertained in cubic centimeters. To determine the theoretical efficiency a simple proportion serves:

35% powder : 40% powder :: 129.3 cu. cm. : 141.2 cu. cm.

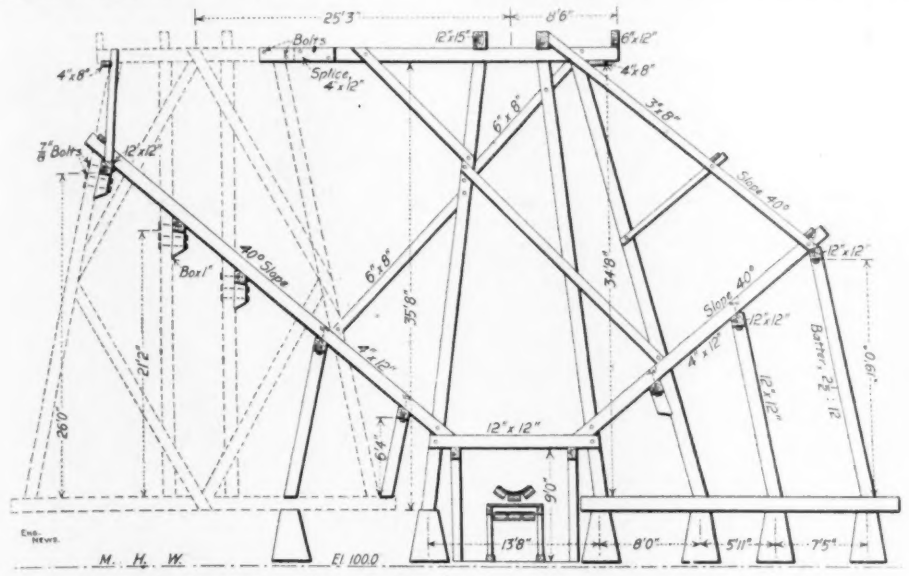


FIG. 3. TYPICAL BENT, SHOWING CONSTRUCTION OF COAL POCKETS.

Careful tests by Mr. Warwick showed not to exceed 4% variation in the effectiveness of samples taken from different parts of the same commercial stick of dynamite, while even less variation was found in sticks taken from various parts of different boxes. This leads to the very important conclusion that misfires in mining or quarrying cannot be attributed to lack of uniformity of cartridges, when the dynamite is not frozen. Tests on two different makes of dynamite showed the effectiveness of varying percentages of nitroglycerine thus:

30% dynamite,	35.3	35% dynamite,	44.5
40% "	43.1	40% "	47.6
60% "	61.7	60% "	63.3

These results show conclusively that the absorbent dope of low grade powders adds materially to their effectiveness, thereby exposing the fallacy of arguments in favor of not tamping ordinary dynamites. Dynamite is much less rapid than pure nitroglycerine, and should always be tamped.

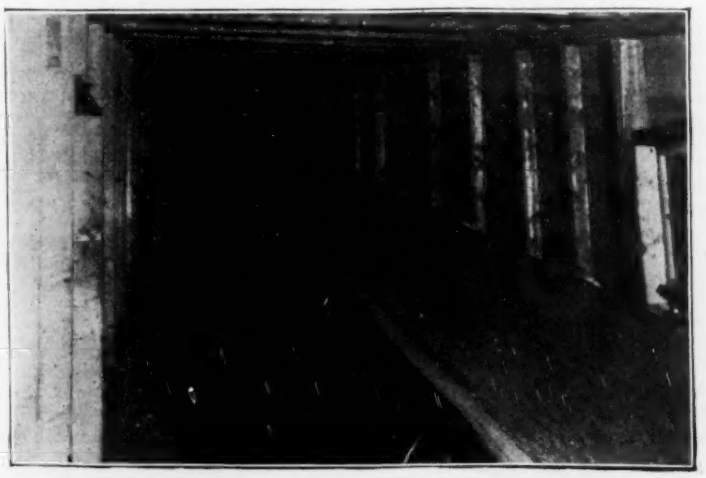


FIG. 4. VIEW SHOWING BELT CONVEYOR INSIDE OF COAL POCKET TUNNEL.

Another set of experiments indicates the relative strength of a given dynamite using different strength of caps:

	3x cap.	4x cap.	5x cap.
35% dynamite	37.4	40.2	44.7
40% "	40.9	41.6	46.8
60% "	59.7	62.2	63.3

From which we see that with 35% dynamite, the 5x cap gives 19½% increased efficiency as compared with the 3x cap; with 40% powder, 15% increased efficiency; with 60% powder, not quite 6% increased efficiency.

Our readers are, of course, aware that too much reliance cannot be placed upon laboratory tests of this kind in deducing rules for practice; and that a low grade powder is generally used, not on account of its relative efficiency in moving rock, but on account of the fact that it does not unduly shatter the rock.

LARGER SEWERS for the lower part of Manhattan Borough, Greater New York, have been declared an early necessity, owing to the erection of large office buildings below 23d St., and large apartment and tenement houses on the east side of the city. Many of the sewers now in use are old and doubtless in bad repair.

THE PAINTING OF THE ELEVATED RAILWAY loop in Chicago, which was referred to in our issue of Oct. 2, has now been completed, and the entire structure has been finished with the almost white tint (light stone color) described in that article. The greater part of the work was given two coats of the light color, which was "structural iron paint," made by Heath & Milligan, of Chicago. On the Fifth Ave. side of the loop, however, the first coat was a jet black graphite paint, made by the Copper Cliff Mining Co., of Chicago, this being afterwards covered with a coat of the light paint. While the finishing paint was fresh the appearance was decidedly pleasing, but the effect is already being marred. Soot and dirt collect on all flanges and projecting surfaces, while the fine steel dust from the third rail is causing red rusty looking streaks. The columns also are splashed with mud, which is very conspicuous on the white surface. The structure has not been painted since its completion in 1896, the color then being a dark steel gray which has not only worn well, but has not shown the dirt and discoloration. It would seem that a similar color would have been best suited for the columns, with a considerably lighter shade for the upper part of the structure. There was, however, a strong demand from the mechanics along the streets for the use of a light color, and the present effect is certainly very pleasing. The stations, especially, light up much better. About 95 tons of paint have been used, and the work of cleaning and painting was done by Mathiesen & Christenson of Chicago.

RAILWAY BUILDINGS are under investigation by a committee of the American Railway Engineering & Maintenance-of-Way Association, and the committee has issued a request for copies of printed contract forms, general specifications and special specifications for mason, carpenter, roofing and other work used by the building departments of various railways. Plans are also desired of typical or standard passenger stations, such as are used at places with a population of 10,000 to 15,000, where a "through" and not a "terminal" station would be in use. These plans should include, if possible, a floor plan, cross-section, and front elevation, so as to give a general idea of the conveniences provided and their arrangement. Replies should be sent to the Secretary of the Association, L. C. Fritch, 1562 Monadnock Block, Chicago.

A REFUSE DESTRUCTOR is to be built at Zurich, Switzerland. It will have 12 cells of the Horsfall type, with an estimated capacity of 13,000 cu. yds. per year. There will be included three boilers and two steam turbines, with direct-connected alternating current generators. The estimated annual operating expenses are about $26,000 and the estimated receipts from the heat $8,000.

DIVERS WILL WORK UNDER ICE this winter at Fairport, O., where J. B. Donnelly, of Buffalo, N. Y., has a contract for pier construction. The air that is to be pumped down to the divers will be warmed, and to provide against sudden changes of temperature suitable houses will be built into which the divers will go before removing their suits.

THE SUBMARINE BOAT "ADDER," on its first official trial in Peconic Bay, Nov. 14, not only lived up to, but exceeded by a quarter knot the specified speed of seven knots awash. The "Adder" then ran a mile submerged, turned and started back for the target, rising but once for a half-a-minute's observation during the two-mile run, at the end of which it fired a torpedo. The torpedo struck within 10 ft. of the center of the target. This remarkable test shows that as a means of harbor defense the submarine boat is probably without an equal. The hollow mast which carried the "periscope" left a slight ripple in its wake, which was the only means of distinguishing the movements of the boat.

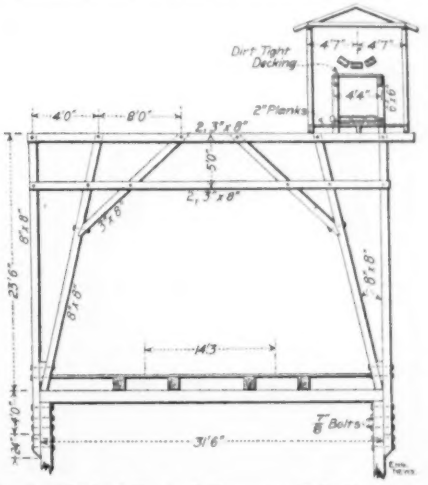


Fig. 5. Typical Bent of Conveyor Belt Structure on Upper Deck of Pier.

BACTERIAL STUDIES OF STREET DUST, made under the direction of Dr. John McG. Woodbury, Street Cleaning Commissioner of New York city, show that smooth pavements and careful cleaning materially reduce the bacterial contents of the air above the street level. Between 2 and 2.30 p. m. on six days included within the period Aug. 5 to 16 Agar plates were exposed for 15 minutes at the curb level and 6 ft. above it, great care being taken to choose exposures disturbed as little as possible by wind currents and by traffic. Care was also taken to have the different observing stations under similar conditions in all particulars except the kind of pavement, its mode of cleaning, and the character of its traffic. Dr. Woodbury thus summarizes the results obtained:

In places where there was a large amount of traffic, where pushcarts were in large numbers, in a tenement district densely populated, as many as 9,600 colonies appear in a 15-minute exposure. In another part of the city, where the pavement was asphalt, although the traffic at this point was quite heavy, the location residential and the avenue well flushed, only 54 colonies were found on a 15-minute exposure, while in another portion of the city, upon a well-cleaned, flushed asphalt pavement, where traffic is extremely light, and where the surrounding property is entirely residential, at 6 ft. above the curb line but five colonies were found.

These results were obtained from seven series of observations, at six stations. Dr. Woodbury is strongly in favor of washing streets with hose as a means of dust prevention. This was done with good effect during the past summer in some of the most crowded tenement sections of the city. Further information regarding street washing and the bacterial studies may be found in Dr. Woodbury's last quarterly report, printed in the New York "City Record" for Nov. 11, 1902.

AN ENGLISH INCLINE PLANE SYSTEM FOR CANALS.

Among the papers presented at the late International Navigation Congress at Dusseldorf were quite a number upon the general subject of surmounting great lifts in canals. As tabulated by Mr. G. A. Saner, M. Inst. C. E., the practical methods for transferring loaded boats from one elevation in a canal to a higher or lower level are as follows:

I. Ordinary locks.

II. Vertical lifts, in which two balanced tanks are suspended over large pulleys.

III. Hydraulic lifts, where the power is applied directly under the tank, as at Anderton, England; La Louviere and Les Fontinettes, in Belgium and France.

IV. Submerged pontoon vertical lift, as recently erected on the Dortmund-Ems Canal. Here the tank is supported on sealed pontoons whose buoyancy is only sufficient to act as a counterpoise, and the actual movement is accomplished by vertical screws operated by electromotors.

V. Inclined plane, or boat railways, where a specially built boat is either floated on a carriage or provided with wheels and hauled out of the water up an incline.

VI. Inclined planes, where the boat enters a tank on wheels, and tank and boat are hauled up an incline. There are two forms of this type: (1) Where the major axis of the tank is parallel to the railway; (2) where this is at right angles to the railway.

The Thames canal-barge lift, described in a paper by Gordon C. Thomas, Engineer of the Grand Junction Canal, England, belongs to Type VI., 2d form. This canal, with its branches, is about 200 miles long, with an average width of waterway of 40 ft. and depth of 5 ft. The locks are of two types, uniformly 87½ ft. long, but 15 ft. or 7½ ft. wide, and 5½ ft. over sill. The 33-ton barge used is 75 ft. long, 7 ft. wide, 3 ft. 4 ins. draft loaded; the 50-ton barge has the same length and draft, but is from 10 to 12 ft. wide.

The country traversed is such as to cause high lifts, and the company has recently completed works of considerable magnitude with the object of reducing loss of time and consumption of water at a point where there was formerly a chain of ten locks adapted only for 33-ton barges. It formerly required 75 minutes for one barge to go up or down, and 30,000 gallons of water were consumed, not including loss by leakage. The total rise of these ten locks was 75 ft. 2 ins.

To meet this difficulty the Thomas lift was devised. The essential principle of this lift is that

Fig. 1. Traveling Docks, Carrying Canalboats, Ascending and Descending Planes at Foxton, on the Grand Junction Canal, England.

of two weights suspended over pulleys, or two weights acting in opposite directions upon planes of equal declivity.

Briefly described, the plant consists of two fixed conduits and two traveling docks. The conduits form the end of the upper reach of the canal and support the necessary gates and "face-fits." The two traveling docks are built of steel plate, and each is 80 ft. long, 15 ft wide and 5 ft deep inside, and is mounted on eight sets of wheels running on four pairs of rails laid on an incline of 1 in 4. These traveling docks are connected by 7-in. steel wire ropes passing around guide pulleys and hauling drums, so that when one dock descends it is balanced by the one ascending, and the engine simply has to overcome the friction of the moving parts.

When a boat is to be raised it is floated into either dock that happens to be in the bottom basin through a gate in the end of the dock; this gate is then closed by means of hydraulic cylinders, and the dock is hauled up the incline with the boat floating in it. On arriving at the top of the incline the dock is held in position against "face-fits" by means of hydraulic rams; the gate at the end of the dock is then lifted simultaneously with a gate in the fixed upper conduit and connection is thus made between the dock and the upper conduit and the boat is floated out.

This lift will pass two boats in each direction in 12 minutes, as against 1 hour 15 minutes required for one boat in the old 10-lock flight. It will pass from 190 to 200 ordinary canal boats in 12 hours of continuous work, and the whole plant is operated by three men. The total cost of the system was $200,000, including plant, machinery, land and the rebuilding of one-half mile of the canal. The operating cost averages $5.88 per day for coal, oil, stores and labor.

The end-gates on the movable docks are lifted vertically, moving in grooves, and means are provided for making the joints water tight. When the dock reaches the top of the incline it makes a practically water-tight joint with the standing work in the upper canal, and forms a continuation of that canal. A similar vertical-lift gate at the end of each of the two upper bays retains the water in the upper canal when the docks are not there. The joint between the end of the dock and the standing work in the upper bay is a direct butt joint between suitable faced surfaces at the bottom and sides of the dock; these surfaces close by a direct butting motion of the dock upon corresponding surfaces on the standing work. This motion is obtained by hydraulic rams acting on the reverse end of the dock, sufficient traverse on the wheel axles being provided for this movement. The rams act as long as the dock remains in place at top. The lower part of the planes descend into an unimpeded continuation of the lower canal.

The two inclined planes are placed side by side on the same gradient, but they are so arranged that at top and at bottom the end of one plane passes the other, so that either plane may be used for ascent or descent. To compensate for the difference in balance in ascending and descending docks, due to the immersion of the descending dock in the lower pond, the normal gradient at the upper end of the incline gradually diminishes with a corresponding decrease in the haulage power. To keep the dock horizontal while traveling on the part where the gradient varies each carriage supporting the dock is provided on the upper side with a duplicate set of wheels, the wheels of the two sets being in different vertical planes, and different sets of rails are provided for these wheels.

The two docks are connected by a balance rope, acting independently; the two hauling ropes to each dock pass around a winding drum in opposite directions, so that the two ropes attached to the rising dock are hauled in while the two attached to the descending dock are let out. As the quantity of water raised about equals that lowered there is practically no loss of water in the operation, and the weight of the load carried by the dock is always the same, as the boats with their load float in all cases.

SOME RESULTS OF THE FIRE ON THE NEW EAST RIVER BRIDGE.

Further examination of the wreck caused by the fire on the New York tower of the New East River Bridge indicate that the damage to the main cables was a little more than was anticipated the day after the fire, when the account published in our last issue was written. A preliminary test of several of the wires from the two southernmost cables was made on Nov. 17 by Chief Engineer O. F. Nichols, M. Am. Soc. C. E. Five wires from each cable were tested, and as compared with the undamaged wires showed a reduction in breaking strength of about 50%. Further tests will be made and all wires which are suspected of having suffered damage will be cut out for a short length over and to each side of the saddle, and the portions removed will be replaced by new wires spliced to the undamaged ends. Altogether, it is now estimated, about 2

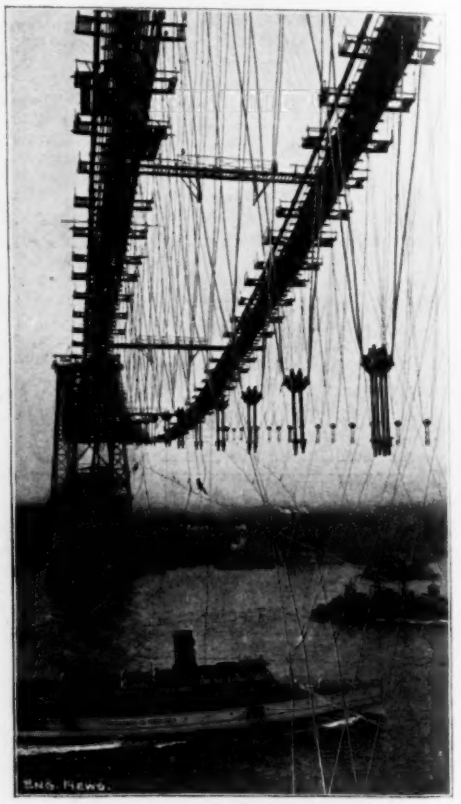


Fig. 1. View of New East River Bridge, Showing Foot Bridges and Main Span Suspenders Before the Fire.

wires will have to be removed from the two cables.

In the account of the fire published by us last week a view from a photograph taken after the fire, and showing the wrecked footbridges, was given. The accompanying view, Fig. 1, shows the appearance of these same footbridges before the fire. This view shows very clearly the wire rope suspenders for the stiffening trusses. It will be remembered that the footbridges were caught in falling by these suspenders, and thus prevented from dropping into the river. Fig. 2 is a view showing the wreckage on the top of the tower which resulted from the fire. To the rear of the view will be seen the remains of the scaffolding on the north end of the tower. There was a similar structure on the south end, but this was burned. The view shows clearly the saddles for the main cables, and alongside them the small saddles for the cables of the footbridges.

STEEL VS. TIMBER FOR SHAFT LINING.

With the growing scarcity of timber and the increasing depth and permanency of mine shafts, there is coming a time when metal will largely displace wood in mining shafts as in other engineering works.

That some mining engineers believe the day of steel has already arrived is shown by the fact that several shafts of the Oliver Iron Mining Co. in northern Michigan have steel in place of timber "sets."

Mr. Frank Drake, of Duluth, read a paper at the last meeting of the Lake Superior Mining Institute, describing the use of steel and its cost as compared with timber, taking for his example "B" shaft of the Pioneer mine at Ely, Minn., which is now 862 ft. deep and lined with steel.

The shaft dips at an angle of 70°, and contains two 6 × 6-ft. hoisting compartments and one 5 × 6-ft. ladder and pipe compartment.

The "sets" consist of 30-lb. T-rails for the hanging wall and foot wall plates, while the end pieces and one of the dividing pieces are 25-lb. rails, the dividing piece between the skip compartments being a 7½-lb. I-beam. The various members of the set are connected with pieces of 3½-in. angle iron, 3½ ins. long, riveted with two ½-in. rivets in each leg. The "studdles" or pieces extending

FIG. 2. VIEW OF TOP OF NEW YORK TOWER OF NEW EAST RIVER BRIDGE, SHOWING WRECKAGE FROM FIRE.

longitudinally between adjoining sets are of 16-lb. rail, each 4 ft. long.

The lagging in the upper part of the shaft where rock is firm consists merely of lines of old wire rope stretched longitudinally about 5 ins. apart, so as to prevent the falling of large pieces of rock. In the softer ground the ordinary 2-in. wooden planks were used for lagging. Since this use of wood materially lessens the safety of the shaft against fire, it is proposed to introduce four sections (4 ft. long) of corrugated steel for lagging to every 100 ft. of shaft.

The weight of the steel lining is supported at intervals of 60 ft. by bearers, four 30-lb. rails being used at each set so supported, the ends of these rails resting in cast-iron chairs placed in the hitches cut in the solid rock.

The rails for the 5-ton skips are 30-lb. rails, with 20 or 25-lb. rails for the "back runners" to prevent jumping the track.

Without going further into the details given in the paper and in the drawings that accompanied it, we come to the matter of costs, which after all is the one of greatest importance. Engineers can as a rule solve any such problem of construction, but of the dollars and cents factor little is known, for which reason every such paper as this is of especial value.

COST OF STEEL LINING FOR "B" SHAFT.

Material for Sets.

2 18-ft. wall plates	360 lbs. @	$0.0171	$6.15
2 6-ft. end pieces	100 " @	.0189	1.89
1 6-ft. dividing piece	50 " @	.0189	.95
1 6-ft. dividing piece	45 " @	.0224	1.00
8 4-ft. studdles	163 " @	.198	3.22
8 connecting angles	26 " @	.035	.91
4 4-ft. back rails	134 " @	.189	2.53
4 brackets for back rails	45 " @	.022	.99
Rivets	10 " @	.038	.38
Cost of material per set			$18.02
Cost of material per ft. of shaft			4.50

Labor on Sets.

11 hrs. laying out and drilling*	@	$0.223	$2.41
12.4 hrs. riveting sets and cutting slots in studdles, including handling	@	.211	2.60
0.6 hr. transporting from shop to shaft	@	.213	.14
Cost of labor per set (933 lbs.)			$5.15
Cost of labor per foot of shaft			1.29

*Includes all incidental handling of material.

Bearers and Chairs.

4 11-ft. pieces	450 lbs. @	$0.171	$7.69
8 cast chairs	128 " @	.04	5.12
8 cast chairs	228 " @	.04	11.52
Cost of materials for set of bearers			$24.33
Cost of labor, cutting and handling			.30
Cost of bearers and chairs per foot of shaft (bearers 60 ft. c. to c.)			.41

Hangers.

30 lbs. refined iron	@	$0.026	$0.78
1.67 hrs. labor forging a hanger	@	.211	.36
0.40 hr. labor tapping and threading	@	.225	.09
Cost of one hanger			$1.23
Cost of hangers per foot of shaft			.23

Lagging.

Material for one set wood lath: 468 ft., B.M., 2-in. plank; 4 ft., B.M., 2 × 4-in. × 6 ft.	@	$14.00	$6.61
8% waste			.53
2 U-bolts, 7 lbs. @	.05		.35
Cost for lagging			$7.49
Labor cutting plank			1.00
Cost per set of wood lath			$8.49
Cost per foot of shaft			2.12

Material for One Set Metal Lath.

222 sq. ft. No. 16 galvanized corrugated steel			$22.64
5% waste and fitting			1.13
Cost per set			$23.77
Cost per foot of shaft			5.94

Since there were 16 ft. of metal lath to every 84 ft. of wood lath, the average cost per foot of shaft for wood and metal lath was $2.73.

Summing up we have:

COST PER FOOT OF SHAFT LINING.

(Exclusive of skip rails, and exclusive of labor of putting lining in shaft.)

Cost of steel sets	$5.79
Cost of bearers and chairs	.41
Cost of hangers	.23
Cost of wooden lath	2.12
Cost per foot, with wood lath only	$8.55
Add if steel lath, 16 ft. to every 84 ft. of wood lath is used	.61
Cost per foot with wood and steel lath	$9.61

N. B.—Most of the sets were riveted with a pneumatic hammer, but a few were done by hand. The slotting of studdles was done by hand, but if some power appliance had been used this item could have been reduced 50 cts. per set or 12½ cts., per ft. of shaft.

ESTIMATED COST OF A WOOD LINING FOR "B" SHAFT.

The following estimate is for sets of 10 × 10-in. timbers in sets 5 ft. c. to c., and does not include the cost of labor in placing the lining in the shaft nor the cost of skip rails:

Materials of Set.

2 wall plates, 10"×10"×20', 334 ft., B.M.	@	$16.50	$5.51
2 end pieces, 10"×10"× 8', 133 " "	@	14.50	1.93
2 divid'g pieces, 6"×10"× 4', 60 " "	@	14.00	.84
8 studdles, 8"× 8"× 4', 168 " "	@	14.00	2.35
4 b'k runners 6"× 8"× 5', 80 " "	@	14.00	1.12
20-ft strap iron ⅛ × 2½ ins., 83½ lbs.	@	.0235	1.96
Bolts 6½ "	@	.06	.19
Total for 775 ft., B.M. and iron in a "set"			$13.90
Labor framing a set			1.60
Cost per set			$15.50
Cost per foot of shaft			3.10

Bearers.

4 pieces, 10 × 14-in. × 12-ft., 560 ft., B.M., @ $17.50		$9.80
Cost per ft. of shaft if bearers are 60 ft. apart		.17

Hangers.

15 lbs. ⅝-in. round iron @ $0.04		$0.60
Cost per foot of shaft		.11

Lagging per Set.

2-in. plank lath, 682 ft., B. M., @ $14		$9.54
9% waste		.86
Total		$10.40
Labor cutting lath		1.36
Cost per set		$11.76
Cost per foot of shaft		2.35
Total cost of materials and framing wooden lining per foot of shaft		$5.73

Thus it will be seen that the cost of wood lining at the unit prices given is $2.82 to $3.43 less per ft. of shaft than where steel lining is used, which, in a measure, is said to be offset by the less excavation required where steel lining is used. Mr. Drake gives the cost of shaft sinking in two shafts sunk at the same time in the same material, "Ely greenstone," but, unfortunately, one shaft was sunk by day labor, while the other was sunk by contract, which makes comparison of little value. It will be seen that "B" shaft required about 23% less excavation than No. 2 shaft, due entirely to the saving in space effected by using steel.

	Shaft "B" Pioneer Mine.	Shaft No. 2 Savoy Mine.
Dip	70°	83½°
Material of sets	Steel.	Wood.
Material of lagging	Part wire rope & part wood.	Wood.
Size of timbers of sets	.....	10 × 12 ins.
Compartments	(2) 6 × 6 ft. & (1) 5 × 6 ft.	(2) 6 × 6 ft. & (1) 4½×6'.
Outside shaft dimensions	6½ × 18 ft.	7⅝ × 20 ft.
Outside area	117 sq. ft.	153 sq. ft.
Rock excavated per ft. of shaft	4⅓ cu. yd.	5⅔ cu. yds.
Progress per working day	1.43 ft.	1.54 ft.

Items of Cost per Foot.

		"B" shaft (steel).	No. 2 shaft (wood).
1.	Contract price of excavation	$15.95	.....
2.	Company labor ac't of excavation	5.74	$22.60
3.	Labor account of lining	2.63	1.45
4.	Shop and team labor	1.74	2.03
5.	Explosives	1.86	1.98
	Timber and lath for sets	....	5.26
	Mining timber	1.87	.63
	Iron and steel	1.52	1.15
	Steel rail	4.70	1.10
	Wire rope for lining	.37	....
	Total, influenced by kind of lining	$35.78	$36.20
	Other items not influenced by kind of lining:		
6.	Miscellaneous labor regularly employed*	$10.71	$8.19
7.	Pipe and fittings	1.17	.88
8.	Miscellaneous supplies	4.68	2.81
9.	Fuel	4.30	2.93
10.	Air	2.89	1.33
11.	Temporary surface buildings and head frame	.28	.58
	Grand total	$59.80	$52.92

*Engineers, firemen, landers, etc.

N. B.—Fuel and air items were roughly estimated, and are subject to much uncertainty.

Here we have a comparison of cost very favorable to the steel-lined shaft, but it must constantly be borne in mind that the steel-lined shaft was sunk by contract labor and the wood-lined shaft by company labor.

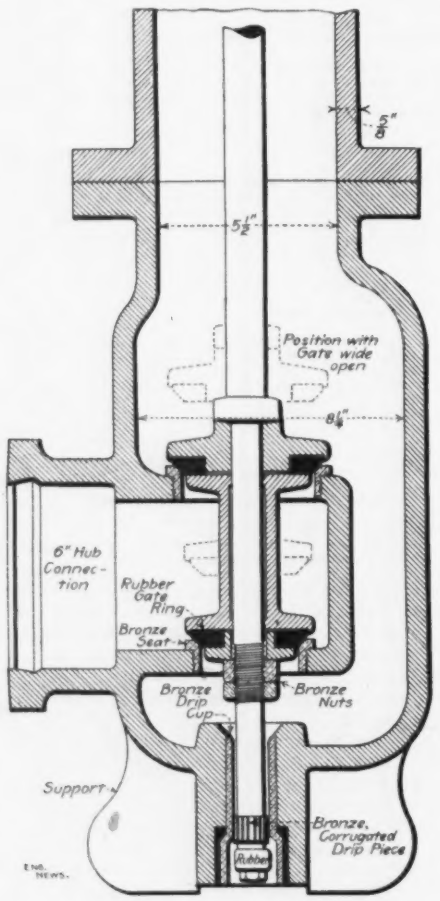
In shaft sinking where, as in these two cases, only 6.3 and 8.7 cu. yds. of solid rock were raised daily, it is evident that the hoisting plant is by no means worked to its capacity, and that there is nothing saved in the labor item of engineers, firemen, pumpmen, etc., by virtue of the smaller cross-section of the steel-lined shaft. Neither can the coal or air items be materially affected by the fact that the steel shaft is smaller, except in so far as the smaller section enables the force to make more rapid progress. As a matter of fact, the steel-lined shaft was not sunk as rapidly as the larger wood-lined shaft, the daily rate of progress being about 7% less, although 38% more rock was daily hoisted in the wood-lined shaft, proving conclusively that there is no saving in the labor cost of hoisting in the shaft of larger cross-section.

As for the item of explosives, we observe that it was $1.86 per ft. or 43 cts. per cu. yd. excavated in the smaller shaft, and $1.98 per ft. or about 33 cts. per cu. yd. excavated in the larger shaft. Thus we see that so little is saved in explosives as to be negligible. In fact, we have left only one item of any importance that may show in favor of the smaller shaft, namely, the item of drilling; but as dynamite and feet of hole drilled are prac-

tically functions of one another in shaft sinking, this item too becomes negligible. Summing up, we may say that since fixed expenses form 25% to 35% of the cost of shaft sinking, and since these fixed expenses form a very large daily item, the final cost per foot of shaft will depend so largely upon the daily progress that differences of 25% in the cross-section area of shafts are negligible. The daily progress in the same kind of rock is entirely dependent upon the number, skill and zeal of the drillers, and the skill of their foreman or manager in reducing to a minimum the time lost for blasting and from breakdowns. The steel-lined shaft must apparently stand upon the merits of the steel lining itself as being, or not being, more economical than wood. If, as in the above instance, steel lining costs some $3 a foot more than wood, then the question is simply one as to its worth as an insurance against fires; and in a shaft costing $60 a foot, an outlay of $3 for such protection would seem good business policy.

A FIRE HYDRANT WITH A BALANCED VALVE.

The accompanying illustration shows a new form of fire hydrant, which is notable for its simplicity of construction, ease of operation, and facilities for complete, automatic drainage. It will be seen that the hydrant really has two valves, the upper one of which opens with and the lower against the pressure, while in closing these conditions are reversed. The valve is similar in construction to the balanced throttle valve used on locomotives.



A Fire Hydrant with a Balanced Valve.

The drip passage is located in the extreme lower portion of the hydrant case, and is always open except when the main valve is open and water is being drawn from the hydrant. When the hydrant is opened, the drip valve, being on the same stem, rises and closes the bronze drip cup, but as soon as the hydrant is closed the water in the hydrant barrel begins to run out through the corrugations shown on the cross-section.

All the working parts of the hydrant can be quickly removed for inspection or repairs by taking off the dome and packing plate. The makers state that with this hydrant no frost case is required, and that water hammer is impossible.

This new design of fire hydrant has just been placed on the market by the Ludlow Valve Manufacturing Co., of Troy, N. Y.

ROAD BUILDING WITH CONVICT LABOR IN THE SOUTHERN STATES.*

By J. A. Holmes.†

In the Southern States the belief prevails that perhaps the best way in which a criminal can benefit the community he has injured is in helping to improve its public highways. And in doing this work without compensation and at a cost actually less, in many cases, than that of his keep in the county jail, he is benefiting his community without imposing on it an additional tax burden; he is not in the ordinary sense competing with hired labor, and he is doing work which hired labor does not care to do unless paid such wages as will prove too serious a drain on the public treasury.

This method of employing convict labor in a majority of the Southern States may be fairly said to have passed the experimental stage, and to have become accepted practice. The accompanying table illustrates the extent to which this method of employing convict labor has already been adopted:

CLASSES OF CONVICTS EMPLOYED ON THE PUBLIC ROADS.

Laws of the different states usually specify that only able-bodied male convicts sentenced for short terms are to be assigned to work on the public roads. In the states of Virginia, West Virginia, Kentucky, Tennessee, Louisiana, Mississippi, Texas, Florida and Georgia, prisoners convicted of misdemeanors only may be assigned to work on the public roads, and for these the sentence does not usually exceed one year, which, when the costs are added, may be thereby extended to nearly two years in extreme cases. In Alabama, in a few cases, all able-bodied male prisoners whose terms of sentence do not exceed two years may be assigned to work on the public roads. In South Carolina this limit is extended to five years, and in North Carolina to ten years.

The experience in North Carolina during the past ten years has shown that all the able-bodied male prisoners whose terms of sentence do not exceed ten years may be successfully employed at the ordinary work of highway improvement. Many such prisoners in different Southern States whose terms of sentence range between one and ten years are now employed under either the lease or contract system, or under state control, and are working on farms or in mines and factories. All of these might be employed in improving the public highways. The expense entailed would not be great; the difficulties which seem to stand in the way would disappear in practice, and the result would of incalculable benefit in helping along industrial and educational development in each of these states.

The experience in California has shown also that even the longer-term convicts can be employed to great advantage by the state in quarrying and crushing stone at one or more central points for use in permanent road building. Stone is being extensively crushed in this way in California at less than half what it costs to do this work with hired labor in other states. The quarries used for this purpose are surrounded by a strong stockade, which also encloses the convict quarters, and the escape of prisoners under such conditions is not greater than that from the state prisons.

*From the "Yearbook" of the U. S. Department of Agriculture, Washington, D. C.

†Chief of Department of Mines and Mines and Metallurgy, Louisiana Purchase Exposition, St. Louis, Mo.

The captured, but as yet unconvicted, prisoners who are unable to give bail often constitute a considerable portion of the inmates of Southern county jails. Under judicious management and an arrangement involving the mutual consent on the part of the prisoner and the county authorities this additional class of prisoners will be found, in large measure, available for highway improvement. This arrangement should provide in each case that when the court's judgment is finally passed, if the prisoner is acquitted, he is to be paid by the authorities a fair compensation for his services already rendered; or if he be convicted, in the carrying out of the sentence of the court the time during which he has already rendered service shall be credited to his account. Under this plan, which has not as yet passed beyond the experimental stage, the acquitted prisoner is set free in possession of a small capital for his support while seeking honorable employment; on the other hand, the prisoner who, for example, five months after his capture, is convicted and sentenced "to the roads" for a period of one year, has, at the time of his sentence already served his county usefully for five months. His sentence will now require of him only seven months additional service before he is set free.

MANAGEMENT OF THE CONVICT ROAD FORCE.

As a rule it has not been found economical to work convicts on the public roads when the squad consists of less than eight or ten men. It is customary to have one guard for each ten or fifteen men, and, of course, this one guard would be necessary even were there only one or two men in the squad. In addition to the guards, there is usually a superintendent of the work; consequently this work is carried on most efficiently when the road force or camp contains from 30 to 50 men. When the number of convicts to be employed on the roads in any county is more than 50 or 60, it has been found better to divide the force into two squads or camps, each having its own local superintendent and guards, and both squads managed under the general supervision of the county superintendent of roads, he in turn being responsible to the county court or board of county commissioners.

It is usually urged against this system of road building that it offers too many opportunities for the escape of prisoners. Experience in many counties, however, has shown that the average annual escapes amount to less than 2%, and the few who do escape are usually recaptured within a day or two. Often the prisoners assigned to the roads are men who live in the community and have families and some property there, and consequently do not care to leave permanently; hence they rarely attempt to escape. Such prisoners as show a desire to escape, or who, in the judgment of the superintendent, are men liable to make an effort in that direction, are usually required to carry a ball and chain, which, while it makes it impossible for the prisoner to run rapidly, does not seriously hamper his movements in the regular road work. On the other hand, the convict who does his work faithfully and shows himself worthy is often rewarded by receiving generous treatment.

Morning and evening the prisoners are marched along the road from and to their temporary quarters, which consists usually of either heavy, large tents, portable houses on wheels, or structures either of wood or corrugated iron, built in sections so they can be easily taken to pieces, removed, and set up again. In order to facilitate their being safely guarded during the night without too great risk and expense, each prisoner, when he goes to bed, has either one foot or one hand fastened loosely to a chain or rod, from which he can be easily released the following morning. The beds or bunks for these prisoners are easily and cheaply made comfortable, and the comfort of their temporary quarters is improved during the summer by ample ventilation and during the winter by the use of stoves.

Employment of Convict Labor on Roads in the Southern States.

State.	No. of counties.	Counties using convicts on public roads.	Average No. of convicts on public roads during 1900.	Average cost—Guarding and maintenance pr convict per day on roads.	Average cost—Of prisoner per day for keeping in county jails.	No. of prisoners usually kept in county jails, and not used on roads.	Average cost of hired road labor per day.	Yearly value of labor—Of convicts used on public roads in 1900.*	Yearly value of labor—Prisoners usually kept in county jails and not used on road.
Alabama	66	2	25	$0.81†	$0.30	789	$0.90	$6,187	$195,387
Arkansas	75	21	62	.85‡	.75	320	.95	16,197	83,600
Florida	45	11	106	.46	.40	437	.92	26,818	110,561
Georgia	137	27	946	.26	.35	1,073	.60	156,080	177,045
Kentucky	119	42	419	.52	.50	583	1.00	115,225	160,325
Louisiana	59	9	67	.50	.40	337	1.00	18,425	92,675
Mississippi	75	12	113	.25	.30	397	.60	18,645	65,405
North Carolina	97	24	643	.24	.30	607	.75	133,508	125,193
South Carolina	40	32	579	.18	.30	404	.75	119,418	83,325
Tennessee	96	37	722	.26	.40	888	.80	158,740	195,360
Texas	229	65	672	.30	.45	1,197	1.15	211,520	378,551
Virginia	100	5	23	.38	.30	329	.80	5,060	72,380
Total or average	1,138	287	4,377	$0.33½†	$0.35‡	7,361§	$0.85	$985,823	$1,739,807

* In estimating the value of this convict labor the per diem paid ordinary laborers in the respective states as shown in the column giving the average cost of hired road labor per day is taken as a basis; and it is assumed that 275 work days may be reasonably counted upon for these states.

† In determining this average the figures for Alabama and Arkansas were omitted, owing to the probability that certain expenses connected with the maintenance of the teams have been, by mistake, included in the figures reported from these states.

‡ In determining this average the figures for Arkansas have been omitted as being abnormally high.

§Concerning this total number of prisoners in the county jails of these 12 states, it should be stated that an unknown proportion, probably in some states at least 50%, of these are persons awaiting trial and unable to give bond. This situation may continue for from a few days to several months. The remainder of these prisoners have already been tried and convicted, but remain in jail idle, at the expense of the county, for the reason that no employment is provided for them.

The cooking and washing at the camps is usually done by some trusty male convicts, especially experienced in these directions, or by the female prisoners, or in still other cases by hired labor. The carrying of water, along with other similar errands, is usually assigned to the younger prisoners, or such as may not be sufficiently strong for the regular work on the roads. Isolated jobs are usually assigned to certain prisoners who, from their associations and generally good characters, are considered safe for carrying on such work without the immediate supervision of guards, and such prisoners are commonly known as the "trusties" of the camp.

The work of road building is usually extended to a distance of 1 or 1½ miles in each direction from the camp, and the camp is then moved a sufficient distance, so that 2 or 3 miles of additional road may be built before a second removal becomes necessary. The work done by these convict road builders includes almost every variety of manual labor necessary in this connection. Thus, in counties like Mecklenburg, N. C., where considerable efficiency has been reached in macadamizing, they drive the teams, handle the shovels and picks, ride the road machines, quarry stone, run the engines, and operate the stone crushers, and occasionally the steam rollers. They spread the gravel or broken stone, and in still other counties they mix the sand and gravel or clay, and give shape to the road surface.

The cost of convict labor in road building, as might be expected, varies greatly with the efficiency of the management and the number of prisoners employed in any squad. The cost per convict per day in this work, including the cost of his food, tobacco, clothing, washing, medical attendance, and guarding, as reported for the year 1900 from representative counties in each of the several Southern States, is as follows:

	Cts. per day.		Cts. per day.
Florida	30 to 50	North Carolina	15 to 40
Georgia	16 " 32	South Carolina	17 " 22
Kentucky	50 " 60	Tennessee	20 " 40
Louisiana	50 " 60	Texas	20 " 40
Mississippi	15 " 45	Virginia	25 " 50

A comparison of the figures given with similar figures for hired labor shows that the cost of convict labor ranges from one-third to one-half that of the hired labor employed on the public roads. In the two Carolinas and Georgia, where the road work is carried on with great efficiency, the cost of maintaining and guarding the convicts at work on the public road ranges in many counties from 20 to 30 cts. per convict per day, and is even considerably less than the cost of feeding them in the county jail. In explanation of this fact, it may be said that during the stay of convicts in the county jail the jailor is paid so much per day for feeding and caring for each; but that while they are employed on the public roads provisions are purchased at wholesale and competitive rates; that the convicts do their own cooking and washing; and that, owing to the usually healthy condition of the convict camps, the cost of medical attendance is almost nothing.

As to the efficiency of convict labor on the public roads, compared with that of ordinary labor, the general testimony from the many counties in the Southern States, is highly in its favor. It must be borne in mind in this connection, however that the hired labor which can be secured in the Southern States for work on the public roads does not belong to the most efficient class, and also that it cannot be easily held longer than a few days or a few weeks at a time; consequently, it is often unsatisfactory. In the case of convict labor, on the other hand, the labor is entirely under the control of the guard and superintendent, and, especially in the case of long-term prisoners, it can be managed so as to reach a considerable degree of efficiency, both in the ordinary work and in the handling of road-building machinery. Convicts thus not only make fairly efficient laborers while engaged in this work, but receive that training and experience which enable them to earn a better living, and hence become better citizens after the expiration of their terms of service.

It has been, therefore, the general verdict from the various counties in the Southern States, where convict labor is employed in road building to any considerable extent, that in both efficiency and cheapness it is decidedly superior to such free labor as is ordinarily available there for this work.

The nature and extent of the work done by convict labor in the improvement of highways in the Southern States can be best illustrated by a brief statement of what has been accomplished in a few counties selected out of a large number that have adopted this system.

GRAVEL ROADS AND SAND-CLAY ROADS IN RICHMOND COUNTY, GA.

Prior to the year 1879 the public roads of Richmond County, Ga., were in a state of neglect. Over a portion of them the surface was a deep sand, the dread of all travelers during dry weather, while the surface of the other portion was of clay, which became a quagmire during the rainy season. Meanwhile the authorities were at a loss to know what to do with their county prisoners, and the lack of a definite policy in this regard resulted either in keeping all the prisoners in the county jail, at considerable expense, or else employing them at miscellaneous jobs about the City of Augusta, the county seat. In January, 1879, the county judge inaugurated a definite policy for the improvement of the public highways of the county, and placed every available county prisoner at work with a view to the accomplishment of this end.

The work of improving and keeping in repair 350 miles of public roads, and 3 miles of bridges was begun with a force of 30 prisoners and 10 mules, and with funds but little more than sufficient to maintain this force upon an economical basis. Fortunately, the work has been pushed continuously to the present date. While naturally these efforts at first met with considerable opposition, the results have proved so eminently satisfactory to the people of the entire county that to-day the system meets with practically unanimous support.

The first work undertaken was the grading and draining of the roads. This was followed by the spreading of a few inches of sand over the clay roads and a few inches of clay over the sandy roads, the cost of this work being but little more than the expense of labor and hauling, as the material was usually found close at hand. For the country roads where the traffic was light, the surface prepared in this way proved eminently satisfactory, often requiring little or no repairing for several years. On the main thoroughfares, near the city, where the traffic was heavier, the sand-clay surface proved less satisfactory, and it was found advisable to spread a layer of gravel on top of it. These roads have a width of 30 ft., and the gravel has been spread over the center to a depth of from 6 to 8 ins., for a width of 20 ft. near the city, and 16 ft. farther out in the county. On the sand-clay roads, in the one case the sand is spread over the clay surface to a depth of 2 to 6 ins.; in the other case the clay is spread over the sandy surfaces to a similar depth. The cost of the gravel roads has averaged about $1,600 per mile, while that of the sand-clay roads has ranged from $100 to $500 per mile, this variation being due to the amount of grading to be done and the nature of the materials used, and the distance it was necessary to haul them. The force at work on these roads at the present time consists of 100 convicts, 32 heads of stock, and a thorough equipment of machinery.

As a result of this well-directed policy, there are now in Richmond county 100 miles of sand-clay roads and 100 miles of gravel roads, all well graded and drained. The old wooden culverts have been replaced by larger ones of brick and smaller ones of vitrified pipe, and the old wooden bridges are being replaced by more modern structures of iron and steel.

SAND-CLAY ROADS IN RICHLAND COUNTY, SOUTH CAROLINA.

The sand-clay roads in Richland County, S. C., are worthy of special consideration, not only as a product of convict labor, but also as an illustration of how much may be accomplished in many localities in highway improvement at small cost, by treating the road surface with a simple admixture of sand and clay. This county, with Columbia as its county seat, is located where the hill country merges into the low lands, and where the beds of coarse sand and clay are in close proximity. After constructing 2½ miles of ordinary macadam road, at a cost of from $2,000 to $3,000 per mile, the county supervisor (who in all South Carolina counties has charge of the public roads) wisely decided to try the simpler and cheaper plan of spreading sand over the clay roads and clay over the deep sand roads, and he has carried forward this work to an extent and a degree of efficiency perhaps equaled nowhere else in the neighboring states. It was not easy to determine the amount of sand in the one case, or of clay in the other, which would give the best final result. Consequently, it has been necessary to watch the resulting road surface for several months, in some cases adding more sand where the surfaces showed a tendency to give way under traffic in wet weather, or in other cases adding more clay where the tendency was for the surface to break up during the dry season. The roads were first cut to a grade of from 2 to 3%, then the surface was given the proper cross-section for shedding water, this surface slope being kept sufficiently gentle to permit the water to run off slowly and not to carry the sand with it. The clay or sand was then hauled in wagons or carts, usually short distances, and spread over this surface for a thickness of from 2 to 6 ins. The mixing of the sand and clay was done by the ordinary travel, which was never stopped, and the surface was finally packed by the wide-tire wagons and carts or a horse roller. Where the supply of sand needed for spreading over the clay road is not found near by, pockets are made in the ditches for catching sand, which is later taken out and spread over the surface.

This work has been in progress during the past four years. Everything, even to the construction of the culverts and smaller bridges, except the guarding and supervision, has been done by convict labor. The size of the force has varied from 40 to 70 prisoners, whose terms of sentence ranged from a few days to five years. During the year 1901 there have been on an average 60 prisoners, divided into two camps. The cost of their maintenance, including the guarding, feeding, clothing, and medical attendance during the year, has averaged 20 cts. per convict per day, as compared with a cost of 30 cts. per day per prisoner for feeding and guarding while confined in the county jail prior to sentence and assignment to the road force.

As a result of this work during the past four years this county now has (out of a total of about 650 miles of public roads) about 125 miles of improved sand-clay roads, 25 to 30 ft. wide, which cost for grading and surfacing about $300 per mile, and 75 miles of similar roads, which, built under more favorable conditions, cost about $200 per mile. In a few places, where the materials were close at hand and little grading was necessary, it is said that this work has been done at a cost not exceeding $150 per mile. The oldest portions of these roads have borne the traffic of three winters and three summers in a highly satisfactory manner, and the annual cost of repairs has not exceeded $10 per mile.

It would be a manifest error to suppose that similarly cheap and satisfactory sand-clay roads can be built in all other portions of the coastal plain region of the South Atlantic and Gulf states, for it must be borne in mind that the character and distribution of the sand and clay deposits of Richland County makes the road-building conditions there exceptionally favorable, and the management of the work has been very efficient. But the success in this county and the measure of success which has followed experiments on a smaller scale in other less-favored localities, certainly suggests a line of policy and experiment which promises cheap and fairly satisfactory results at small cost over much of the area of the South Atlantic and Gulf states.

GRAVEL ROADS IN SHELBY COUNTY, TENNESSEE.

Modern road building in Shelby county, Tenn., began about 15 years ago with the construction of the gravel turnpikes which now radiate from Memphis, the county seat, toward the north, east and south. Since that time the county has built some 350 miles of these excellent turnpikes, and is said to have expended in their construction and maintenance approximately $860,000. The grading for these roads has been done largely by the county convict force; but the larger part of the quarrying, hauling, and spreading of the gravel has been done by hired labor under the contract system, only a limited portion of this work having been done by the convicts.

The management of these roads is vested in a turnpike commission consisting of three members, with the chairman of the county court as its head. The management of the convict force is vested in a workhouse commission or board, both commissions being appointed by and being responsible to the county court, which decides as to the tax to be levied for the support of the convicts and the general road-improvement policy to be followed. The turnpikes as constructed have a right of way of 50 ft. On this roadway gravel has been spread over its central portion to a width of 14 ft. near the city and 12 ft. farther out in the country.

The gravel used in the construction of these turnpikes is found in deposits varying from 5 to more than 20 ft. in thickness in many portions of the county. It consists mainly of small, well-rounded pebbles of quartz, chert and flint, cemented together with oxide of iron and a limited amount of clay. When these beds are broken down by blasting, and this gravel is spread on the road with care, so as not to separate from the pebbles the cemented material, it re-forms a hard, firm surface, which makes an excellent roadway. Where the distance does not exceed two or three miles, it is hauled by wagons from the pits to the road, but for longer distances it is hauled by rail to the nearest station, whence it is carried by wagons to the roads on which it is to be spread. Large quantities of the gravel used have been hauled by rail for a distance of more than 100 miles.

These gravel deposits are usually owned by private individuals, and the road authorities pay for it at the pit from $2 to $3 per car of 14 cu. yds. When spread over the roads for a thickness of from 6 to 8 ins., it has usually cost from $1,000 to $2,000 per mile.

The convict force during the year 1901 has included from 120 to 140 men, of which from 80 to 100 have been employed on public roads during the months of May to November. During this work season the prisoners have occupied temporary quarters in the country, traveling each day a distance of from one to five miles to and from their work. During the winter season, from November to April, the entire force of convicts is kept in the permanent quarters on the workhouse farm near the city, being used partly for farm work and partly for road and street improvements near by. The cost of employing these convicts on the public road is said to average about 40 cts. per day per prisoner. The force has already rendered a most important service to the county by helping in the construction of its present turnpikes; but there will doubtless be a decided improvement, both in the efficiency and economy of operating this convict force for road-building purposes, when the management is the same as that for the turnpikes, and when a better system of movable stockades or quarters is adopted, so that the prisoners may camp at night near to their place of work, and continue their road-building operations throughout the entire year.

MACADAM ROADS IN MECKLENBURG COUNTY, NORTH CAROLINA.

Modern road building in Mecklenburg County, S. C., and indeed modern road building in the state of North Carolina, may be said to have begun with the adoption of

road laws nearly 25 years ago, which authorized each township in the county to levy a special tax for the maintenance and repair of its public roads, and permitted the commissioners to levy a special tax for the support of its convict labor in the permanent improvement of the county highways. This work has now been in progress for two decades on an increasingly large scale and with growing efficiency. At the present time this county maintains in connection with its public-road work two convict camps of from 50 to 60 prisoners each.

The road-building equipment at each of these camps includes a quarrying outfit, a steam road roller, a stone crusher and engine, a road machine, scrapers, carts, wagons, mules, shovels, picks, etc. In the management of these convicts there is a guard for each 10 or 15 prisoners, and a local superintendent who has charge of the camp and the road work done by it. The entire road work of the county, including the management of both these convict camps, is under the control of the county superintendent of roads, who is also an engineer, and who reports monthly, and oftener if need be, to the board of county commissioners, which board decides upon the amount of road tax to be levied each year and exercises a general control over the work.

The county being situated in the hill country, the old roads with their steep grades have had to be relocated at certain points, and they have been graded by cutting through hills and building up intervening depressions until this grade work as seen to-day resembles that along a railway line. These roads radiate from Charlotte, the county seat. They have a width in the central township of 40 ft., of which 12 ft. in the center has been macadamized, and a dirt road has been arranged on each side of this. In the rural portions of the county the width of the road has been contracted to 30 or 35 ft.; the macadam track has in many cases been reduced to a width of 10 ft., and has been placed on one side of the road. This gives a double track: the macadam, to be used almost exclusively during the rainy season, and the earth road, to be used generally during dry weather. This double-track system, which is much preferred by the farmers, prolongs the life of the macadam road by relieving it from traffic during dry weather.

All of this work is being done by convict labor, and the long period (five to ten years) for which many of the prisoners have been sentenced permits their being trained for expert work in the way of handling machinery and grading and macadamizing the roads. In connection with the cost of this work, it may be added that the maintenance of the convict force (including salaries of the guards and camp superintendent, and the clothing, board, tobacco, and medical attendance for the convicts) averages for the entire force for the year from 28 to 30 cts. per convict per day. These convicts are housed throughout the year in comfortable portable structures, made of wood and corrugated iron, framed in sections, so that they are easily taken down and moved by a small portion of the squad from one point to another along the road.

During the past twenty years, and largely during the past decade, 104 miles of such macadam roads have been constructed in Mecklenburg county by convict labor. At first, as might be expected, the progress made was slow and the work not always well directed, but year by year the county authorities have profited by their own experience and that of others, and during the past few years there has been a decided improvement both in the rate of progress and efficiency of management. During the year 1901, 12 miles of road have been graded and macadamized, at a cost ranging from $2,000 to $3,500 per mile, including the grading and macadamizing, the construction of culverts and abutments, and the materials for new bridges. The county is now expending annually something more than $40,000 on the improvement of its highways; and the proposition that this expenditure is the best-paying investment the county could possibly make is accepted by every class of citizens, and even by the convicts themselves, who seem to feel a genuine pride in the excellent highways they are building.

SEWAGE DISPOSAL AT SHELBY, OHIO.

By Benj. H. Flynn.*

This city is located in the north-central part of the state on the headwaters of the Mohican River, and just south of the state divide. On account of the small drainage area tributary to the Black Fork, as it passes the city, it was not able to care for even the small amount of sewage sent to it before the introduction of the present complete system. Recognizing this fact the plans for sewering the city very properly included a purification plant.

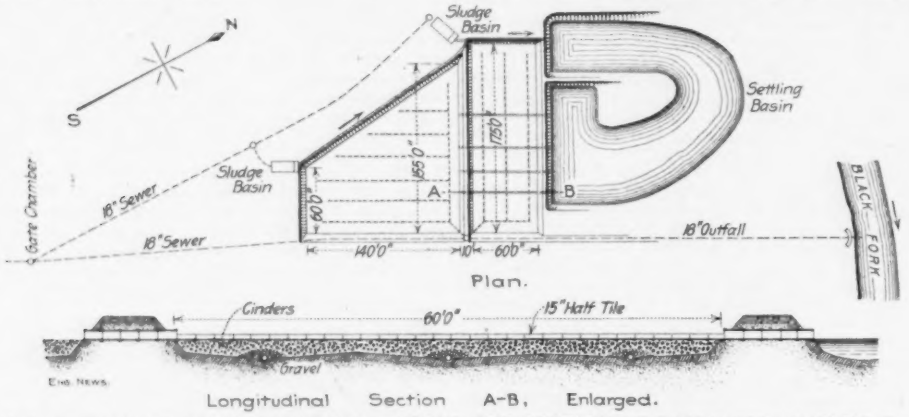


FIG. 1. PLAN OF SEWAGE DISPOSAL WORKS AND SECTION OF FILTER BED, SHELBY, O.

Under the direction of Mr. John B. Weddell, of Mansfield, O., there was constructed for Shelby some 15 miles of sanitary sewers and about two miles of storm sewers, maintaining strictly the principle of the separate system. These sewers were practically completed in 1899, but the disposal works were not completed until the following year. In the meantime the small amount of sewage was sent direct to the creek through a long outfall sewer, extending three miles north from the center of the city. This carried the sewage to the stream at a point much below the corporation line and prevented a nuisance from this source within the city limits. The storm sewers empty directly into the creek at the nearest point, as also do a number of private sewers carrying manufacturing wastes. At times these latter pollute the stream and cause more or less trouble.

It is estimated (Nov. 1, 1902), that 90% of the population is within reach of the sanitary sewers, but as yet there are only 250 connections, representing some 1,300 people, or 26% of the total population. In 1900 Shelby had a population of 4,685, and it is now claimed that the figure is in excess of 5,000. The average daily flow of sewage is about 200,000 gallons and the maximum is 300,000 gallons. The greater portion of this is ordinary domestic sewage, diluted with the infiltrated ground water; the sanitary sewers carry but little of the industrial wastes.

The sewage disposal works were constructed during the summer of 1900 and put in operation in November of that year. The plant consists of two sludge pits, a settling basin and two intermittent filters of cinder and gravel, shown in plan by Fig. 1, and partially shown by the view Fig. 2. It is located on a 25-acre farm, purchased in April, 1897, lying three miles north of the center of the city, along the Big Four Railway and the Black Fork of the Mohican River. The outfall sewer leads down to this farm and, as stated, for the first year discharged its sewage directly into the stream. At a point [illegible] ft. from the end of the outfall, at a manhole and gate chamber, an 18-in. line diverges from the main sewer to carry the sewage to the two sludge pits, or septic tanks. Gates are provided at the deflector so the sewage can be sent to the disposal works or to the Black Fork directly, but the latter outlet is not used.

Each sludge pit consists of a brick basin, 10 × 24 × 6 ft. deep, with a capacity at the flow line of about 8,000 gallons. The basins have 8-in. walls and 4-in. bottoms, and are provided with a frame covering, shown in the view, Fig. 3, divided into four large doors, so that any portion of the bottom may be reached for cleaning. The inlets and outlets consist of 15-in. tiles, placed in the upper part of the wall, just below the cover. A wire screen, with ½-in. mesh, is placed across the lower end to hold back all floating matter.

From the sludge basins the sewage flows in 15-in. half tile carriers to a large settling reservoir, nearly half an acre in area and holding about 250,000 gallons. This is an irregularly shaped basin, formed partly by the excavation for the levees. It is in clay soil, with the sides and bottom not protected in any way. After flowing through this reservoir the sewage goes to the filters, being conducted by 15-in. half tiles to the north edge of each bed.

There are two filters, with areas of 15,120 and 10,500 sq. ft., respectively, or a total of 25,620 sq. ft., or 0.59 acres. These filters are underdrained every 20 ft. with 6-in. sewer tile, leading to 10-in. main underdrains, which in turn join the main outfall sewer at a manhole opposite the center of the beds. Over each underdrain the filter bed is 2 ft. deep, but it slopes to 18 ins. deep midway between the drains. (See section in Fig. 1.) Over and around each drain there is placed a layer of gravel 6 ins. deep and 6 to 8 ft. wide. The balance of the filtering material is bituminous coal cinder, crushed and cleaned as well as possible. The underdrains are partly sunk into the bottom of the bed and each is provided at the upper end with an inclined cleaning pipe, and at the lower end with a lamp or inspection hole, placed just before the junction of the latter with the main drain. The ends of the tiles were laid as close together as possible, and each joint was wrapped with a strip of cheese cloth. The sides of the filter and the embankments are of the natural soil, and support a vigorous growth of grass and weeds which can in time be turned into a fair sod.

With the average flow of sewage, 200,000 gallons per day, the sludge pits hold nearly two hours flow. The sewage is also about three hours in reaching the disposal works from the city. With these conditions it is not surprising that the

Fig. 2. Settling Reservoir and North Filter Bed, Showing Tile Carriers to South Bed.

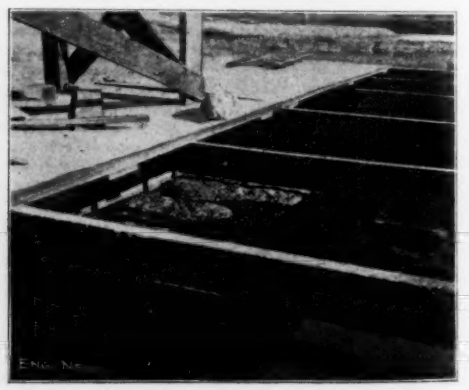


Fig. 3. Top of Sludge Pit or Septic Tank.

VIEWS OF SEWAGE PURIFICATION WORKS, SHELBY, O.

*Engineer Ohio State Board of Health, Columbus, O.

basins designed for sludge pits, only, should develop an excellent septic action, and produce an effluent freed from about 50% of its organic matter, and do this without the production of a large amount of sludge. The sludge pits, or more properly septic tanks, have the so-called characteristic scum of the septic process, and liquify a large percentage of the solid matters sent to them. They have been cleaned but once (October, 1901) since the plant was put in operation, when about 25,000 gallons of liquid sludge, with added sewage, was removed. The sludge was stirred up with a portion of the sewage, then pumped with a hand power trench pump to tank wagons and distributed over the fields adjoining. Originally the large settling basin was not used, the sewage being sent direct from the sludge pits to the filters, but this method clogged the surface of the latter too quickly and the large basin was put in use. Opposite the inlet to this basin considerable sludge collects, which is removed from time to time to the fields. The sewage in this reservoir has a rather turbid appearance, but gives off no odor, and is not offensive in any way. Some odor is developed at the sludge pits, but not enough to make the plant offensive, especially in its isolated location. Since the introduction of the settling reservoir one raking of the filter beds, with a toothed harrow, has been sufficient to keep them open. They require more or less weeding, however, during the growing season.

Chemical Results Obtained at the Sewage Disposal Works, Shelby, O.
(Averages, in parts per 1,000,000 of composite night and day samples.)

Sample of sewage....		Raw.	Septic.	Settled septic.	Effluent.
Color		28	21	21	18
Turbidity		0.42	0.05	Slight.	Trace.
Sediment		Consid-erable.	Decided.	Slight.	Trace.
Odor of sewage		Strong.	Strong.	Sewage.	Musty.
Oxygen required		18.74	7.13	5.81	3.39
N. as	Am. albumin'd	2.065	1.610	0.765	0.348
	Ammonia free.	3.865	3.410	2.900	3.040
	Nitrites	0.028	0.056	0.058	0.085
	Nitrates	0.18	0.50	0.52	0.50
Chlorine		37.6	31.2	29	30.8
Alkalinity		261	249	237	222
Encrust'g constitu'nts		210	208	198	223
Total solids		978	855	839	811
Loss on ignition		263	249	233	227

From the few analyses given herewith it seems that the septic action is excellent, but that the filters give but little nitrification. As far as can be determined this may be due to the lack of aeration of the septic effluent or to the too long treatment in the settling basin. No provision was made for aeration, as it was not supposed that the sludge pits would materially affect the character of the sewage beyond freeing it from sediment. However, the final effluent is clear and free from odor and disappears rapidly in the small stream, leaving practically no trace.

The cost of the construction of this system is as follows:

Sanitary sewers, 15 miles	$60,000
Mains and outfall, one mile 12-in and 2½ miles of 18-in	12,600
Right of way for outfall	4,000
Sewer farm, 25 acres	2,500
Purification works, original	3,000
Purification works, additional	400
Engineering and contingencies	2,500
Total	$85,000

Of these amounts only about $3,900 can be charged up to the construction of the disposal works proper, making, with the cost of land, a total of $6,400. If an outlet for the sanitary sewer could have been obtained near the city, then the cost of the right of way and a portion of the cost of the outfall would properly be charged to the disposal works. The main sewer, filter beds, and land was provided for by an issue of $25,000 of 4½% bonds, payable $1,000 yearly after April 1, 1913.

The plant is cared for by one man for the use of the remainder of the sewer farm, making the cost of operation equal to the interest on about $2,200 or about $100 per year.

NOTES FROM CITY ENGINEERS AND OTHER MUNICIPAL REPORTS.

FITCHBURG, MASS.—The annual appropriation for engineering work in this city of 31,531 inhabitants (census of 1900) has remained stationary at $3,000 ever since 1894. Mr. David A. Hartwell, City Engineer, states in his last annual report that during the period named every other department of the city has had its appropriations increased from 10 to over 100%. The expenses in 1900-1 overran the appropriation by $805, but it is obvious to anyone familiar with such work that even $3,800 is a niggardly sum for all salaries and other engineering expenses in a city like Fitchburg. The total salary account for the city engineer, two assistant engineers and four rodmen was $3,005.51, besides which $120 was paid to a stenographer and typewriter. The balance of the expenditures were divided as follows: Livery and car fares, $332; hardware, paper and supplies, $251; lumber and stakes, $33; stone bounds, $25; telephone service, $25; printing, $15.

HAVERHILL, MASS.—This place, with a population of 37,175 in 1900, spent still less for engineering work in 1901 than did Fitchburg. According to the last annual report of Mr. Robert R. Evans, City Engineer, he had an appropriation of $2,900, besides $18 of "receipts," and carried over a balance of $55 to the next year. The salaries of the engineer and his assistants amounted to $2,472. The remaining $392 was distributed for various purposes, $106 going for a typewriting machine and desk, $76 for stationery and supplies, and $53 each for printing and car fares.

MEDFORD, MASS.—Manhole dirt pans used here are 14 ins. in diameter at the top, 0.5 in. at the bottom, and 9 ins. deep. They are made of No. 23 black iron, with a heavy wire rim and a bail. After being made as described they were galvanized and then fitted with three galvanized wire loop hangers, 8 ins. long.

Sewer gagings are made at Medford occasionally, the flow from 18 different sections, connected with the Metropolitan Sewerage System, being recorded. The maximum total daily flow in gallons is given for these months as follows: March, 1899, 2,992,100; September, 1899, 1,869,900; December, 1900, 3,126,350; July, 1901, 2,190,800; December, 1901, 3,575,300. Mr. Wm. Gavin Taylor is City Engineer.

MELROSE MASS.—The completeness with which roots and dirt will stop drain and sewer pipe when given an opportunity is shown by several half-tone views in the last report of Mr. W. Dabney Hunter, Engineer and Superintendent of the Public Works Department. The accompanying view, from a photograph kindly furnished us

View Showing 12-in. Bend in Drain at Melrose, Mass., Filled with Roots and Dirt.

by Mr. Hunter, shows a 12-in. bend which was rendered useless in the way mentioned.

WORCESTER, MASS.—The net cost of sewer maintenance during the year ending Nov. 30, 1901, was $117.19 per mile for 151 miles of sewers, 2,288 catch-basins and 5,807 manholes. Cleaning sewers cost an average of $51.29 per mile. There were removed from catch-basins 12,986 cu. yds. of refuse, in loads of 1.2 cu. yds. each, at a cost of 61 cts. per cu. yd., including hauling the stuff away. Mr. Harrison P. Eddy is Superintendent of Sewers.

GENEVA, N. Y.—A tar macadam and asphalt plant was installed by the Department of Public Works in 1901, and is described in the corresponding annual report. The plant includes a portable sand and stone heater, with two 3 × 18-ft. drums; a 50-in. exhaust fan, a 25-ft. elevator, a standard asphalt mixer, made by the Iroquois Iron Works, Buffalo, N. Y.; two 1,000-gallon asphalt tanks, fitted with steam coils; a tar pump, and an 18-ft. belt conveyor for moving crushed stone from the city crushing plant. The cost of the plant was $3,045, not including an engine, which was hired for the season at a rental of $175. The plant has a daily capacity of 700 yds. of either tar macadam or asphalt pavement, and is credited with a saving of over one gallon of tar per yard of pavement, besides the saving of labor. Mr. C. T. Church is Superintendent of Public Works.

PHILADELPHIA, PA.—The net cost of garbage collection and disposal, the removal of ashes and other dry refuse, street cleaning and cleaning sewer inlets for the year 1901 was $1,030,604. The garbage is treated by the reduction process. Mr. Sylvester H. Martin is Chief of the Bureau of Street Cleaning and Mr. Wm. C. Haddock is Director of Public Works.

WASHINGTON, D. C.—Chloride of lime plays so important a part as a disinfectant and is so generally relied upon in many quarters that the following quotation regarding the weakness of the commercial product sold in Washington, D. C., is well worth citing as a general warning to all users of that disinfectant. The quotation is from the last report of Dr. W. C. Woodward, Medical Health Officer, Washington, D. C.:

> An examination was made to determine the frequency with which "chloride of lime" conformed with legal requirements. As this substance is largely used for disinfecting, and depends for its disinfecting properties on the amount of available chloride which it contains, it is desirable that it should in all cases conform to the requirements of law. In not a single instance, however, did it do so, the amount of available chloride varying from 5 to 17.3%, whereas the legal standard, that of the United States Pharmacopœia, is 35%. It may be asserted with some force that the material purchased was "chloride of lime," whereas the pharmacopœia standard refers to the chlorinated lime. The term "chloride of lime" has, however, no technical meaning, and is ordinarily regarded by the laity and even by the medical profession as being synonymous with chlorinated lime. If it does not mean chlorinated lime, it has no definite meaning, and dealers are at liberty to sell, under that name, any preparation whatsoever.

JACKSONVILLE, FLA.—When, in 1893, the city voted $75,000 for an electric light plant, the price of gas was $3 per 1,000, "with some discounts to large consumers," and electricity cost $15 per month for 1,200 c. p. arc lamps, and 28 cts. per 1,000 volts for incandescent lights. The city plant was put in operation March 25, 1895, with the following basis of charges: 2,000 c. p. arcs, $7.50 per month for all-night and $6.25 for 12 o'clock service; 7 cts. per 1,000 volts for incandescent lamps. The last report of the trustees of the water-works and improvement funds contains statements regarding the financial operations of the plant which purport to show that even at these low rates the plant, with extensions, has been a paying investment to the city, besides saving consumers large sums. The private electric lighting plant has been shut down and the gas rates charged by the private company have been reduced to $2 per 1,000 cu. ft. It should be added that the private lighting plants were under the same control. Mr. B. F. Dillon is chairman of the trustees named above. The city lighting plant was badly damaged by the great fire of May, 1901.

NASHVILLE, TENN.—It seems strange enough to read in these days of enlightened public opinion that the good people of Nashville have recently authorized the city to subscribe $1,000,000 to the capital stock of the Nashville & Clarksville Railroad, yet it is so stated in the last annual message of Mr. Jas. M. Head, Mayor of Nashville. The campaign is described as "one of the most vindictive and malignant" in the history of Nashville, but nevertheless more than the requisite three-fourths of the vote cast were in favor of the proposition. The line, if built, will connect with the Illinois Central on the west.

OBERLIN, O.—Sewage disposal works were established here in 1894 (see Eng. News, June 14, 1894). They now include 3½ acres of land underdrained for filtration, and 1¾ acres not drained, which is used for broad irrigation. The annual report of the sewer commissioners for 1901-2 states that:

> During the dry months of summer sulphate of alumina

to the amount of about two grains per gallon of sewage has been added to the sewage in the village. It became well mingled with the sewage in flowing to the farm, and aided materially in precipitating the organic matter in the pits. The pits have been used now for nearly a year as septic pits, and have proved very satisfactory.

Mr. W. B. Gerrish is City Engineer.

GRAND RAPIDS, MICH.—Concrete pavements, curbs and sidewalks on two short and narrow streets are described in the last report (1901-2) of Mr. L. W. Anderson, City Engineer. Heretofore courts have been improved by laying tar-concrete on cobblestone foundations. Briggs Court has a 23-ft. roadway and 3½-ft. sidewalks, and Donald St. has an 18-ft. roadway and 4-ft. walks. The upper end of Briggs Court was enlarged to a 30-ft. radius to allow teams to turn around. Portland cement was used for walks, curbs and roadway. The walks were given a 3¼-in. base and the roadway a 6-in. base of 1 part cement, 3 parts sand and 5 parts screened gravel, the latter ranging from 1 to ¼-in. in largest dimensions. The sidewalk had a top ¾-in., and the roadway 1 in. thick, each consisting of 1 part cement and 2 parts sand. The following is an extract from the specifications for this work:

The curb and walk may be constructed together or separately, as the contractor may desire. The stone shall be laid alternately, with tarred paper between them, or straight steel templates at least 3-16-in. thick shall be used. The templates shall be kept clean and well oiled to prevent adhesion of the cement. All joints shall be tool-finished to the satisfaction of the engineer, and such joint markings shall correspond accurately with the joints made by the template. Any variations shall be cause for rejection of stone. The concrete pavement shall be laid in alternate 6-ft. sections, with at least a ¼-in. expansion joint at the curb, and a template made joint at the crown. A coarse brush finish shall be given the surface.

driving on the roads. As soon as the ground was thoroughly thawed the shale hardened again without further rolling. The gutters on the steeper grades washed out somewhat with the heavy spring rains, and it will be necessary to pave them with brick, which is now being done. Otherwise, the shale covering is very satisfactory, and from its cheapness, abundance and ease of repair, seems to be the best dressing we could use at present for light driving. The color, a dull red, makes a very pleasing contrast with the green grass and foliage, which has been much admired by capable judges.

MINNEAPOLIS, MINN.—Bicycle paths with a total length of 40.19 miles were in use at the close of 1901, of which some 24 miles were built by the city in 1900 and 1901. The earlier paths appear to have been built privately (some, certainly, by the Wheelmen's Association), and to have been assumed by the city in 1900. In May, 1900, the city began to construct paths, and during the most of the summer it employed three crews, consisting of 12 to 15 men, and three or four teams. Most of the paths built in 1900 had wood curbs "about 6 ft. toward the street from the gutter line," formed by 2 × 8-in. pine nailed to 4 × 4-in. posts 32 ins. long, 4 ft. c. to c. Any readily available material was used for the subgrades, which was first brought up flush with the curb, then rolled with a horse roller, then covered with 1 to 2 ins. of clay, when available, or else loam or other heavy material. This binder was rolled, then covered with ½-in. to 1 in. of gravel and rolled again. Screened gravel was bought during about one-third of the season, then gravel was taken from vacant lots or bought, according to circumstances. Driveway crossings of 2-in. plank were provided.

The cost of the 11.77 miles of paths built in 1900 was $11,006, divided as follows: Gravel, $347; lumber and nails, $2,197; tools, $142; signs, $34; labor, $8,285. In 1901 there were built 12.82 miles at a cost of $9,898, and $2,809 was expended in repairing 27.37 miles of old paths. The 12.26 miles of ordinary construction cost $7,771, divided as follows: Gravel or stone dust, $52; lumber and nails, $1,435; tools, $92; labor, $6,193. The details of construction for 1901 are not given further than a statement that for repairs, "as well as for many of the new paths," limestone screenings were found "the best and cheapest." Mr. C. W. Sublette is City Engineer of Minneapolis.

TORONTO, ONT.—The city engineer was the lowest bidder on 13 contracts in 1901, and the work was done by the city, in accordance with its custom. Repairs to asphalt pavements were made during the year at a contract price of $1.23 per sq. yd. for 2½-in. surface, $1.09 for 2-in., and $4.75 per cu. yd. for concrete foundations. New cedar blocks can be laid on existing foundations for about 65 cts. per sq. yd., and are "good for at least five or six years." During 1901 all cedar block paving was in the nature of renewals except in the case of one street. Mr. C. H. Rust is City Engineer of Toronto.

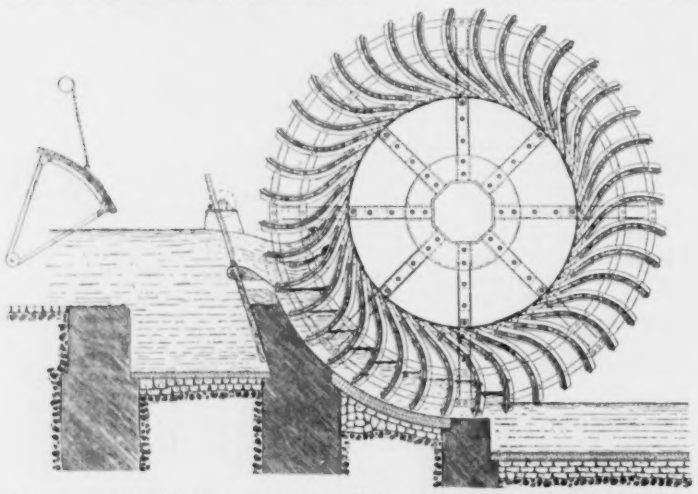


FIG. 1. BREASTWHEEL FOR RELATIVELY LARGE FLOW OF WATER.
Built by A. Wetzig, Wittenberg, Germany.

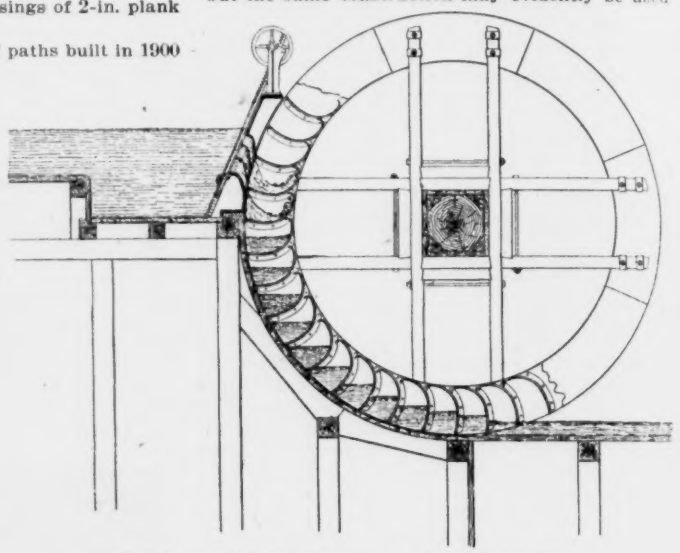


FIG. 2. BREASTWHEEL WITH GUIDE VANES.

SPRINGFIELD, ILL.—Horse and steam road roller work is compared by Mr. Arthur Hay, Engineer of the Pleasure Driveway and Park District, in his report for 1901-2, as follows:

Roller.	Hours.	Cu. yds. rolled. Total.	Cu. yds. rolled. Per hour.	Cost. Total.	Cost. Per cu. yd.
Horse	314	2,534	8.0	$236	$.096
Steam	350	4,040	11.5	118	.029

A six-ton reversible roller, drawn by four horses, was used until a ten-ton steam roller was bought. The material rolled was shale from coal mines, which was hauled about two miles for 50 cts. per cu. yd. for hauling alone, extra men being engaged for loading. The shale was "laid" (not stated whether before or after rolling) 6 ins. thick at the center, tapering to 2 ins. at the sides of the road. The cost of loading, hauling, spreading, sprinkling and rolling the shale averaged 10.8 cts. per sq. yd. of roadway. The shale is described by Mr. Hay as

slate and waste from the coal, which is burned by the oxidation of the slack coal and sulphur in the dump to a substance about as hard and of the same color as fragments of drain tile. Mixed with this is some fire-clay, which is about the same color when burned, but which is totally unfit for roadmaking, as it slacks and swells and quickly falls to mud.

The experience with this material under traffic is thus described by Mr. Hay:

These shale roads have now been down about six months, and have passed through a very hard winter, and are still in excellent condition. Ordinary rains only seem to beat them harder, but for two or three weeks in spring, when the frost was coming out of the ground, the surface of the shale softened and it was necessary to prohibit

SOME MODERN BREAST WATER WHEELS.

The utilization of water power, revived in the last one or two decades by the demands of electricity, has long gone beyond the old style of mill wheel and has become entirely a question of turbines and impulse or jet wheels. Nevertheless there are many corners of the world where the old styles of overshot or breast wheel are still in service. It may be desired to turn to account a low fall or chute, in order to secure a few horse-power for some minor manufacturing purpose. Here turbines are out of place; they are either impossible or very expensive. On the other hand it may be a simple matter to lead the water through a vertical gravity wheel of the time-honored kind, and thus with the simplest possible construction to get the small amount of power desired.

On this account drawings of some such wheels as built at the present day may be interesting, and we therefore reproduce two of them from "Der Praktische Maschinen-konstrukteur."

Fig. 1 shows a breastwheel which is designed for a relatively large flow. The blades are set close together, and are carried up toward their inner end, to give a steep slope against the incoming water. The reaction on this slope adds to the simple gravity effect in driving the wheel. The amount of water supplied is determined by a parabolic-curved overfall which can be shifted up or down by a rack and gear, as indicated in the drawing. The wheel shown is made of channel, bar and angle iron framing with blade surfaces of wood. It is intended for a wooden shaft, but the same construction may evidently be used with an iron shaft. An emergency gate is provided some distance back of the wheel, arranged to be dropped by a rope release which can be worked from any floor of the factory driven by the wheel.

The wheel illustrated in Fig. 2 is also a breastwheel, but differs considerably from the other in its detail arrangement. The most important difference is the method of feeding the water to the wheel. Here several curved guide vanes in series are used, which direct the water upon the blades of the wheel at a particular angle. The wheel has much shorter blades than that shown in Fig. 1, and they are curved upward to meet the following blade, thus forming closed pockets. The openings of the guide vanes can be partly or entirely closed by a sliding gate, movable up or down by the gear shown, to regulate the amount of water supplied to the wheel. As to construction, Fig. 2 shows a design worked out entirely for timber setting, the wheel itself being also of wood. The arms and rims of the wheel are made of wood, and are arranged to receive a wooden shaft; the blades, however, are of sheet metal, supported on bent angle brackets attached to the rims.

This style of wheel is stated to be used for heads of 8 to 25 ft., and a water consumption of 3 to 35 cu. ft. per sec. The wheel shown in Fig. 1 is used for heads of 2 to 6 ft., and for a flow of water up to 200 cu. ft. per sec. Both the wheels shown are built by the firm of A. Wetzig, in Wittenberg, Germany.